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RESEARCH AND EXPLOITATION OF FOREST PRODUCTS

INDUSTRIAL raw materials from land that lend themselves to economic conversion and utilisation by man can be broadly classed as agricultural, sylvicultural and mineral. Agricultural products like cotton, jute, and food crops are receiving considerable attention, and it is expected that comprehensive schemes of research on these will be included in the post-war plans. The sylvicultural products, on the other hand, have not been so favoured, partly because of the unceasing suggestion from all sides that India is mainly an agricultural country and partly because of the neglect in exploring the industrial potentialities of the large variety of raw materials that the country is endowed with. The latest available figures indicate that the surplus forest revenue of India is hardly 26 per cent. as against 35 to 50 per cent. in more technically advanced countries of the West. Of the 400 million people in the country only about a million and a half are employed directly in the collection and distribution of forest raw materials. In independent India we may look forward to a sustained and purposive programme of intensive research and exploitation in this field. It may, therefore, be desirable to outline here a plan for the study and development of industries based on the forest wealth of the country.

The principal products of recognised economic value in Indian forests are timber, fuel, grass, bamboo, sandal and lac. A number of minor products also contribute in a small measure to forest revenue. Investigations carried out at the Forest Research Institutes of Dehra Dun, Coimbatore and a few other centres have no doubt helped in improving the productivity of the forests of India and better exploitation of the forest products with increased financial returns. But the enormous scope for research and exploitation can be gauged by the fact that we have yet to evolve timber trees coming early into maturity, render saplings and timber pest-proof, discover pulp for varieties of paper and rayon; nor have we exhausted the uses or perfected economical methods of production of sandal wood, sandal oil, lac, lac dye, essential oils, gums, resins and grasses,

With regard to timber afforestation following deforestation as a routine practice is all that is mostly being done. Comprehensive, long-term investigations on plant physiology, genetics, hybridisation, forest botany, entomology, mycology and allied branches of sylviculture still remain to be undertaken. Basic and wide knowledge of our national resources are of obvious necessity in turning the forest wealth to greatest advantage. For it is strange that the Indian forests which include practically all types in the world, ranging from dry tropical to Alpine and moist temperate forests, should not be able to supply the right pulp for paper or rayon. While trying, therefore, to induce foreign plants of known utility to grow in our forests, unceasing search must be made for indigenous wood for modern industrial uses. A basic survey coupled with technical progress and sound forestry should certainly promote in increasing measure the use of indigenous pulp.

Sandal culture and utilisation is another instance demanding attention at the hands of both the scientist and industrialist. Sandal wood is a monopoly, particularly of South India, enjoying a very high priority among products of luxury and pharmaceutical value in the world. The income from this source forms a respectable fraction of the forest revenue in Mysore State. The necessity for careful nurture and protection of the plant from pests will be all the more appreciated when it is realised that sandal requires about forty years before it is ready for harvest. But as things stand to-day the annual loss of sandal, especially in the form of saplings as a prey to spike disease, is beyond computation. It is needless to emphasise that an effort in this direction cannot be made too soon. To eliminate or reduce the incidence of the disease, fundamental investigations into the physiology of the host as well as of the virus responsible for the disease are essential. Only such a study is likely to suggest sure methods of tackling the pest. Further, production of sandal oil could also be raised by evolving strains of early maturity and higher oil content. In utilising the oil there could certainly be a more thorough study of its applicability in the pharmaceutical industry. During the last decade a good deal of work was carried out at the Indian Institute of Science on the physiological and biochemical aspects of sandal and its leguminous host plants as well as on the nature of spike disease. With the establishment of the Board of Scientific and Industrial Research in Mysore it is to be hoped that these investigations will be continued towards a fruitful conclusion.

Shellac offers similar and equally extensive scope for both basic and applied research. Shellac is also vulnerable to pests. But in addition, the production is critically influenced by the vagaries of the weather. There have been years when the crop of lac has been cut down to fifty per cent. of the normal production owing to failure of rains. In the early thirties investigations were carried out at the Indian Institute of Science on the nature, production and composition of lac. The Indian Lac Research Institute, Ranchi, has made valuable contributions to our knowledge on the dielectric properties, constitution, effect of storage, etc., of lac. Applied researches on the utilisation of lac derivatives, esterification of rosin with shellac, manufacture of de-waxed lac have also been carried out at this Institute. A good number of industrial applications of lac have been thoroughly investigated by the Imperial Institute, London. We hope that coordinated, comprehensive schemes of investigation covering the various aspects of production and utilisation of lac will be continued.

The accepted method of exploiting by-products as a means of cheapening the principal commodity can be applied to lac also. The scarlet dye of the lac insect, which formed the main product in the ancient industry, can find to this day a demand among silk dyers. The dye is not inferior to any of the synthetic products in its sheen or fastness to light. But the drawback is the inconstancy of the shade of the dye extracted from different batches. The immediate demand is, therefore, the working out of methods of quality control in the dye. The washings of the stick-lac, now running to waste in the industry, is also a potentially rich source of nitrogen and vitamins. If we are, therefore, able to work up systematically all the produce of the lac insect, ensure quality in them and press them into service in the national economy of the land, there should indeed be no need to despair of the future of the lac industry.

The forest department is also shouldered with the pressing responsibility of providing a ceaseless supply of fuel to the nation's homes. But the conservators of forests have yet to insist on their right to demand a thrifty and economic use of the fuel which they have to grow with so much pain and care. For it is deplorable that in burning fuel, as we now do, we are able to utilise little more than twenty per cent. of its calorific value. This waste can

hardly be justified when known methods of fuel technology ordinarily followed in coal-burning countries make possible a far less wasteful use of the national supply. It is within the domain of research on forest products to work out ways of conservation of fuel, not only in forests but in the citizen's home, the cumulative value of which will mean an enormous saving of an essential commodity. It is to be hoped that the authorities in charge of forestry will formulate comprehensive plans of investigation on all aspects of the problem and insist on their execution with the same speed as other technical and industrial schemes are favoured with.

EDITORIAL NOTES

MORALITY OF SCIENCE

UNTIL before the atom bomb, Science was considered non-moral. The search for the laws of nature and the knowledge of them was thought to be the right of every one who would seek it. No discrimination in gaining such knowledge and training for further discovery was tolerated. But the burst of the atom bomb on Hiroshima and Nagasaki has suddenly awakened the scientist's conscience and sense of responsibility. It has made him doubt if Science is, after all, outside the purview of human ethics. Prof. Norbert Weiner of the Massachusetts Institute of Technology voiced the opinion of all thinking men when he raised serious objections against freely imparting his findings on controlled missiles. In his letter to a fellow-worker—probably on a war weapon—he questions the current morality of disseminating all knowledge indiscriminately. "In the past, the comity of scholars has made it a custom to furnish scientific information to any person seriously seeking it," writes Prof. Weiner. "However, we must face facts: The policy of the government itself during and after the war, say in the bombing of Hiroshima and Nagasaki, has made it clear that to provide scientific information is not a necessarily innocent act, and may entail the gravest consequences. One, therefore, cannot escape reconsidering the established custom of the scientist to give information to every person who may inquire of him. The interchange of ideas, one of the great traditions of science, must of course receive certain limitations when the scientist becomes an arbiter of life and death.

"The measures taken during the war by our military agencies, in restricting the free intercourse among scientists on related projects or even on the same project, have gone so far that it is clear that if continued in time of peace this policy will lead to the total irresponsibility of the scientist, and ultimately to the death of science. Both of these are disastrous for our civilisation and entail grave and immediate peril for the public."

Continuing, the professor writes, "The experience of the scientists who have worked on the atomic bomb has indicated that in any investigation of this kind the scientist ends by putting unlimited powers in the hands of the people whom he is least inclined to trust with their use. If, therefore, I do not desire to participate in the bombing or poisoning of defenceless peoples—and I most sincerely do not—I must take a serious responsibility as to those to whom I disclose my scientific ideas."

These contentions of Prof. Weiner and men like him—who are many—strongly remind us of the age-old Hindu precept which enjoins the *Guru* to be careful, circumspect and severely strict in choosing his successor who will be called upon to carry forward the torch of Knowledge. And to-day we are driven to think on almost exactly similar lines, that all men could not be trusted with the power for evil.

The importance of psychological fitness for the respective professions is being increasingly recognised. In this era of the atom bomb, therefore, a huge responsibility devolves on the scientist in imparting to the world at large new scientific information, especially information of the kind likely to be misused as a weapon of war. It is clear that the profession of science can only be entrusted to those who entertain such an abhorence of war and human suffering that they would rather sacrifice science as a career than co-operate with the warmonger in any form. Another and more practical way of preventing the abuse of science is for the scientists, as a class, to refuse, in the words of Sir J. C. Ghosh, to be the camp followers of politicians. We trust the urgent realisation of the gruesome consequences of the use of the atom bomb will swell the volume of opinion in favour of humane and rational science taking the lead in the management of world affairs. For it is abundantly clear that current politics has woefully failed to keep pace with the progress of science which has broken barriers and erased man-made frontiers. We wish the Atomic Scientists, led by Professor Einstein, every success in their efforts to rationalise the application of science for the promotion of human happiness.

FACTORY TRAINING FOR INDIAN STUDENTS OVERSEAS

WE are receiving repeated complaints from our scholars in the United Kingdom and United States that facilities for practical training are lacking in both the countries. While the universities and technical schools have extended a warm welcome to Indian students, the factories and industrial plants have failed to encourage them. Mr. Krishnamurti from Akron, Ohio, writes in a letter to *The Hindu*, "With great difficulty I was able to arrange and complete three months' training in the Firestone Tyre Company ... I have been trying to arrange for further practical instruction,

but so far no company is prepared to take me in. This is the fate of many other Government scholars in this country. It is time that the Government did something in regard to arranging for practical training."

The situation is not much different in U.K. Last April at the National Union of Students' Congress, held in Liverpool, both Indian and other foreign students protested against the ban on the admission of non-British students to certain factories in Britain. Mr. Marshall of the Metropolitan Vickers, regretting the ban as unfortunate, said that it was a Government ruling and could not be helped. The ruling appears, to say the least, rather anomalous when viewed in the light of the generous invitations of the British Government to India to take advantage of the facilities for Technical training in Great Britain. And it is well known that we are seeking the co-operation of the technically advanced countries more for the benefit of practical training of our students in industries not yet established in India rather than for high academic accomplishments. We learn that the Chinese Government have been able to negotiate with a number of industrial firms in America for entertaining their students. The extension of similar hospitality to India by Britain and U.S.A. at a time when it is most needed will be a friendly gesture that is bound to be greatly appreciated.

LABORATORY TECHNICIANS

WE are informed that the Council for Technical Education has appointed an Expert Committee to consider the subject of training laboratory technicians and submit concrete proposals for a comprehensive scheme. All scientific workers will agree that such a scheme of training has been long overdue in this country.

As conditions obtain at present, much of the valuable time of the research worker is spent in getting ready the routine apparatus and reagents required for his specialised experiment which will perhaps occupy only a fraction of the time he had to spend on the preliminaries. No doubt advanced and elderly workers can command their students to do these for them. But it will be realised that the students, although they must go through this mill for their own good, are not exactly meant for this job. The result of all this is the unnecessary overworking of the scientist and an obvious slowing down of the pace of scientific research.

On the other hand, in the advanced laboratories of the West the scientist need only confine himself to the working out of the precisely specific problem of research he has set himself to accomplish. The trained laboratory technician cleans the apparatus, prepares the reagents, does the weighings, cuts sections, carries out simple glass-blowing, recovery-distillations, etc., as per the instructions of the research worker, leaving him more time for the essential library and laboratory work. No wonder, therefore, that both the quality and quantity of scientific work turned out by such workers easily excel that of the worker who has to be a mere hack. The need for training large numbers of technicians is all the more pressing in view of the very limited research talent in the country which must be strictly rationed out and devoted to tasks that only trained scientists can do.

A word for the technician himself. Recently Prof. Haldane mentioned that many a young man starting as a laboratory technician has graduated himself to eminent chairs of science in European and American Universities. This speaks not only of the potentialities of some of the people who are compelled by circumstances and natural accidents of life to start from the lowest rung of the ladder but of the generous universities who are always on the alert to exploit scientific talent wherever it is to be found. We are sure that the experts on the Committee will so formulate the scheme of training that opportunities for training oneself as an original investigator are not wanting for those technicians who have it in them to develop into good scientists.

The dearth of laboratory technicians is now so great and the need for a continuous supply of them will be so persistent that it would be advisable for large institutions to establish a standard course to be recommended by the expert Committee as a regular feature among their courses of training. Men so trained, it is needless to say, will be readily absorbed by industrial, technical and public health laboratories as well as by universities and research institutions to the obvious benefit of all.

WATUMULL RESEARCH FELLOWSHIPS

THE Watumull Foundation announces the award of ten Watumull Research Fellowships in Indian Universities to the following candidates: —*Agriculture*: Mr. O. N. Mehrotra, J.K. Fellow, College of Agricultural Research, Benares Hindu University; and Mr. K. M. Shahani, Imperial Dairy Research Institute, Bangalore. *Education*: Mrs. Leelavati M. Rao, Child Education and Psychology, Allahabad University; and Mr. L. J. Bhatt, Lecturer in Education and Psychology, Teachers' Training College, Baroda. *Chemistry*: Mr. Jyotirmoy Bhattacharya, Demonstrator, Applied Chemistry, Science College, Calcutta. *Economics*: Mr. Premchand Srivastava, Lecturer in Economy, Jain College, Arrah, U.P. *Political Science*: Mr. K. L. Srivatsava, Professor of Politics, Christian College, Indore. *Physics*: Mr. Biswanath Bhattacharya, Benares Hindu University. *Medicine*: Dr. D. R. Nagpal, Lady Linlithgow Sanatorium, Kasauli. *Mathematics*: Prof. Surya Prakash, Professor of Mathematics, Herbert College, Kotah (Rajputana).

PALÆONTOLOGY AND THE MEASUREMENT OF GEOLOGICAL TIME

Comments and Suggestions for a Plan of Research by the Committee on the Measurement of Geological Time in India*

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(A) Introduction

AMONG the many useful activities of the Department of Scientific and Industrial Research at New Delhi, under the directorship of Sir Shanti Bhatnagar, F.R.S., one of the most interesting promises to be the work of the newly formed Committee on the Measurement of Geological Time.

A palæontologist can here be of assistance only indirectly, because fossils can at best give only a relative measure of Time. But I appreciate the honour of being asked to work on this Committee, for I realise that in these investigations a concerted plan of action can help to make the approach more rational, and, in any case, a palæontological check may be found desirable.

A perusal of the valuable Memorandum issued jointly by Professor M. N. Saha, F.R.S., and Mr. Wadia[1] suggests the following comments as to the place which palæontology can occupy in such a scheme of research.

(B) Possibilities of the Palæontological Approach

The strata of the earth's crust were at first recognised only by their lithological characters. Their relative ages could be known only by their order of superposition as observed in the field. Later it was discovered that they could be more reliably identified by their contained organic remains which on the whole, and in a general way, were found to be characteristic of them even where the lithology was not the same. Gradually it was realised that fossils were important landmarks of organic evolution and, therefore, of geological history. Now they are our trusted guides to geological age, dependable even in new and distant regions of the world, and in areas of disturbed stratigraphy. They are particularly reliable when considered in their natural assemblages in the strata, that is, as floras and faunas. With the close study of morphological variations palæontology is growing into a fine science; it has already made possible a zonal subdivision of the strata which occasionally reaches a surprising degree of minuteness and accuracy, and is applicable over wide areas.

Except for a few apparent discrepancies which can be explained away, the facts of palæontology have given consistent results for dating the rocks.

The question still remains whether two floras or faunas of similar composition in distant parts of the globe are strictly contemporaneous. But as it seems that the rate of dispersal of species is far more rapid than the rate of their extinction, geologists generally accept homotaxial strata as being practically of the same age.

Latterly the microfossil investigation of sediments has come to the aid of the stratigrapher and this aspect of palæontology finds increasing application in explorations for oil and coal, where a close knowledge of the stratigraphical sequence is important. We now know that not all sedimentary formations which outwardly appeared to be unfossiliferous are really devoid of organic remains. Some of these have recently been shown to be astonishingly rich in microfossils representing both plant and animal groups. The Saline Series in the Salt Range of the Punjab is a good case in point;[2] so also the glacial tillites at the base of the Gondwana system in Australia[3] and South Africa[4]—and quite recently organic remains have also been detected in the Talchir Boulder Bed near Chittidil in the Salt Range.[5] Owing to their wide dissemination in the body of the rock-matrix microfossils can sometimes provide an age index even if small bits of the rock collected at random are analysed.[6]

Experience suggests that, barring the most ancient sedimentary formations (Silurian or older), all freshwater beds and even marine shallow water deposits may now be expected to reveal plant microfossils, provided they have not undergone serious metamorphism.

In metamorphosed sediments the megafossils are generally too badly obliterated to be of much use to the palæontologist. It would be interesting to enquire as to whether the microfossils in such rocks can escape obliteration. Metamorphosed shales bearing deformed leaf-impressions should be put to the microfossil test.

There are great areas in India, particularly in the Peninsula, covered by ancient sedimentary rocks of unknown or disputed age. Very few megafossils have been found in these strata, nor are we likely to find many more in the future. An attempt may usefully be made to recover microfossils from samples of these rocks which should be collected from localities and horizons by geologists who best know the areas.

Igneous intrusions are known to traverse some of these rocks of doubtful age. It has been suggested by Professor Saha and Mr. Wadia that a systematic examination should be undertaken of the radio-active content of the minerals in these intrusive rocks. If any recognisable microfossils are found in the associated sedimentaries, and if their age can be even broadly estimated, we shall at least have a maximum age limit for the intrusives, for these cannot be older than the sediments into which they were injected.

(C) Limitations

But with all this, the limitations of the palæontological method must be recognised. Palæontology, even at its best, can give us only a relative measure of the ages of strata. Very

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little is at present known of the rate at which new species arise, disperse through space, become modified or extinct, and are eventually replaced by others in the course of evolution. Nor is it to be expected that the tempo of evolution has been uniform under all conditions, even for the same species. These intricate phenomena are determined by a network of factors relating to the response of living beings to an ever-changing physical background.

The palæontologist, moreover, is helpless in dealing with rocks which are unfossiliferous; and there are other circumstances, only too familiar to those who have to deal with fossil fragments, which limit our power of estimating the age of a flora or fauna.

For anything like an absolute measure of Time we must have resort to physical methods of investigation—mainly, it seems, to a radioactive determination of the minerals composing the rocks (except in the case of varved Pleistocene sediments which can be exactly dated by counting backwards as shown by De Geer and his school and certain other beds, like those at Oeningen, in which, again, seasonal variations can be detected). But the physical approach also has its limitations. For one thing, the radio-active method is only applicable to certain types of rocks.

(D) Need for a Concerted Plan of Investigation

Obviously, therefore, the problem of the Measurement of Geological Time can best be handled by a concerted plan of action. While it is clear that the main line of attack must be physical, a palæontological check can be of considerable use, and in the initial stages of investigation may save much groping in the dark. We can at once appreciate this fact from the known history of the discussions which ultimately led to the present broad agreement between physicists and geologists upon the question of the age of the earth.

For example, when dealing with interstratified sedimentary and volcanic rocks, or where igneous intrusions traverse sedimentary strata of unknown age, it may be possible to determine the approximate age of the sedimentary beds palæontologically before the physicist, with his more exact methods, attempts to arrive at precise results. This aspect is more fully dealt with below, with reference to the Deccan lavas and some other volcanic rocks in India.

Normally, we should expect geophysics and palæontology to give concordant results. Any large disagreement would suggest a more critical examination of the evidence from both sides. This should give us a clearer insight into the relative value of the two modes of attack, and help to dispel exaggerated notions concerning the reliability of a particular kind of evidence.

(E) Suggested Lines of Investigation (*Mainly Palæobotanical*)

At the present moment the following aspects of the problem appear to the writer to be worthy of investigation from the palæontological (mainly palæobotanical) side.

(a) *Microfossil investigation of Indian sedimentary deposits of unknown or disputed age, some of which are traversed by intrusive igneous rocks.*

(i) *The Cuddapah, Vindhyan and other formations in the Indian Peninsula, and the Purple Sandstone in the Salt Range.*—In a brief note just published, J. Hsü[7] records an attempt to obtain microfossils from the Purple Sandstone at Khewra, which is generally accepted as Lower Cambrian but which some geologists have placed in the Tertiary. Tertiary sediments generally yield some clear evidence of vascular plants, such as shreds of wood, spores or pollen, or the chitinous remains of highly evolved insects. Hsü failed to discover any such fossils in the Purple Sandstone, thereby indirectly supporting the idea that the Sandstone is a very ancient deposit, dating back to a time prior to the origin of vascular land plants, or of the winged insects. Similar investigations might usefully be extended to the Cuddapah, Vindhyan and other presumably ancient sediments.

(ii) *Various pre-Carboniferous sedimentaries in the Himalayas whose age is open to doubt.*—In the Kashmir-Hazara region, and extending north towards the Pamir plateau, D. N. Wadia has recorded the occurrence of land conditions during a long period of the Early Palæozoic. From the Central Himalayas, Hayden, von Krafft, Griesbach, La Touche and others have collected rocks of ages variously reported as Ordovician and Silurian, some of which contain plant remains. All such occurrences of plants in strata of ancient date would well repay critical examination. In some of these specimens there are clear signs of vascular plants suggesting members of one of the earliest groups of land plants that we know, namely, the Psilophytales. This material is being examined by the writer through the courtesy of the Geological Survey of India, but more extensive collections need to be made, and each collection examined separately, horizon-wise, both for its microfossils and megafossils. We may thus obtain data of some chronological interest concerning a part of the geological scale which has so far yielded very little fossil information in this country.

(iii) *Strata in the Poonch State and adjoining areas* which Wadia[8] correlates, probably correctly, with the Lower Gondwanas, but in which no fossils have yet been found. These may on microscopic examination yield spores similar to those discovered in carbonaceous Lower Gondwana shales in the Peninsula and in the Salt Range, and thereby confirm the suggested correlation.

(iv) *The Upper Gondwanas of the Coromandel Coast*, which L. F. Spath[9] is inclined to regard as Cretaceous, may be worthy of a closer attention than has yet been bestowed upon them. A microfossil analysis would very probably show them to be of Jurassic age. Some Upper Gondwana rock-samples from Tabbowa in N.W. Ceylon, on other grounds regarded as Jurassic, and probably contemporaneous with the Madras coast Gondwanas, yielded a rich microflora of Bennettitalean cuticles and coniferous woods, giving a clear verdict in favour of a Jurassic age.[10] The island of Ceylon is generally thought to be a region particularly poor in organic remains. But there is good reason to believe that with the microfossil method a very rich fossil flora can be brought to light in the Mesozoic sediments of Ceylon.

(*v*) *Certain beds in the Solan-Simla area and in the Kosi area of Eastern Nepal* of which the age is uncertain but which are now provisionally correlated with the Talchir Boulder Bed, may usefully be searched for microfossils. With the discoveries, recently made, of microfossils in the Gondwana tillites in Australia, S. Africa and the Salt Range,[5] it should be possible to demonstrate the correctness or otherwise of the suggested correlation of the Blaini[18] and other beds in these areas with the Upper Carboniferous, by subjecting rock samples (particularly the shaley and dolomitic rocks within the Blaini beds) to the same technique. The Infra-Krol Series may also reveal spores comparable with those of the Lower Gondwana shales in the Peninsula and in the Salt Range. Some rock samples kindly sent to me by Dr. West and Mr. Auden are awaiting examination.

(*β*) *Age-levels of different horizons of the Deccan Trap lava pile.*

The writer has for several years been publishing fossil evidence to show that the Deccan Traps are Tertiary, and that the whole of the eruptive period in the Deccan was probably only a brief episode within the Eocene.[11] This idea needs to be checked both by palæontologists and physicists. Palæontologically this can be done by making a more intensive and extensive search for fossils throughout the Intertrappean series from its presumed base in the Nagpur-Chhindwara and in the Rajahmundry areas to its top along the Bombay coast. The results should be compared with geophysical age estimates of different horizons in the volcanic series.

The flora (and fauna) from each easily accessible intertrappean bed should be examexamined strictly on its own, and a comparison of the whole series from top to bottom should be undertaken to see if there is any large evolutionary change, apart from local facies differences which have been already demonstrated and commented upon in papers by the writer and his co-workers.

It has been suggested by geologists that the middle part of the Deccan Trap series lacks fossiliferous intercalations. This idea seems to need careful scrutiny; with the microtechnique now at our disposal even a thin layer of dust definitely known to belong to an Intertrappean interval may yield microfossil material. All junctions between successive lava flows, wherever easily accessible, should be carefully examined for freshwater intercalations, however thin; and the red bole found in the region of Poona should be micro-analysed.*

(*γ*) *Age of the Khewra Trap in the Salt Range.*

Recent discoveries of microfossils in the Saline Series of the Punjab Salt Range show a post-Cambrian age for the Series;[12] this fact, considered with the stratigraphical relations of the beds, goes to prove that the Series is Eocene, as first suggested long ago by Koken and Noetling. *If the Khewra Trap is definitely a contemporaneous lava flow and not a subsequent intrusion*, even a rough lead-ratio analysis of the trap rock should give a clear verdict, because the alternatives are so far apart (something like 60 or 70 million years for the Eocene; and about ten times that figure for the early Cambrian—even a higher figure for the pre-Cambrian). If the object is merely to decide between these two ages the physicist can even afford to include in his calculations any non-radiogenic lead that the Trap may contain.

Fresh, unweathered samples of the Khewra Trap have been sent for analysis to Professor A. C. Lane of Harvard but the result is still awaited.*

(*δ*) *Age of the* Cardita beaumonti *Beds.*

These beds have commonly been regarded by Indian geologists as Upper Cretaceous, mainly, it seems, on the strength of the "species" known as *Cardita* (*Venericardia*) *beaumonti* founded by D'Archiac and Haime. It has been suggested by Rutsch[13] that this specific name covers a series of closely related forms varying in age from late Cretaceous to early Tertiary. Obviously, therefore, the Indian form or forms should be subjected to a critical re-examination. I have elsewhere[14] sounded a warning that a new species thus founded on material from a fresh area should not without further reasons be accepted as an age index.

The question is of some importance in relation to the debated age of the Deccan Trap. A radio-active analysis of the associated igneous rocks may be helpful but it is important first to ascertain whether these igneous rocks really represent a lava flow or only an intrusive sheet; so far as we know this all-important question has not yet been decided, though much speculation has been indulged in upon the relation of these igneous occurrences with the true Deccan Traps of the Peninsula.

A microfossil analysis of the sedimentary beds may throw some light upon their age if parallel data are also collected from strata of known Upper Cretaceous and Eocene age. We have at present very little information concerning the microstructure of arthropod chitins and on the minute structure of animal shells. It is possible that a close comparison of these skeletal parts under the microscope will reveal specific and even generic differences between forms too readily accepted as identical. The suggestion is not unwarranted, for we have ample experience of this sort from the plant world. It is beyond our scope here to suggest a large-scale investigation of all sorts of animal chitins, living and fossil, on the lines of work now in progress in many parts of the world on spores, cuticles and woody tissues of plants, which have yielded fruitful results in the classification of fossil plant fragments. But comprehensive micropalæontological investigations on the lines indicated would seem to contain great promise of results which should be of value to the stratigraphical geologist,

* Specimens of the bole are being examined at my suggestion by Professor K. V. Kelkar of the Geology Department, Fergusson College, Poona.

* On the retirement of Professor Lane, recently, Dr. John Putnam Marble, Chairman of the Committee on the Measurement of Geological Time under the National Research Council of Washington, has very kindly agreed to help. This offer of co-operation is deeply appreciated.

quite apart from their intrinsic interest in the taxonomy of animals. Many fossil forms identified by their general features are likely to prove distinct if examined more minutely. *Lingula ovalis* has for many years been cited as a remarkable case of persistence of type from the Early Palæozoic down to the present day. The writer finds it hard to believe that this presumed (and widely accepted) identity between the ancient form and the modern would stand the test of scrutiny under the microscope.

(*e*) *Geochronology of the Pleistocene of Kashmir.*

There is a wide and fascinating field, largely untapped, for research in India on the lines laid down in the classical work of Baron de Geer and his school in Scandinavia, North America and other parts of the world.[15] The Karewas of Kashmir contain numerous outcrops of varved clays which would well repay examination. A whole team of field geologists can be employed in making, firstly, a general survey of all such occurrences, then a series of collections of varved columns which should be combined into a local chronological scale. It may ultimately be possible to make detailed correlations with the glacial and interglacial cycles in Scandinavia. The palæobotanist can help to complete the ecological picture by working out the pollen flora in the varved sediments, which should indicate local changes in vegetation and climate.[16] The important work of Dainelli, de Terra, Norin and others on the Pleistocene of Kashmir is a clear indication of the possibilities that lie before the Indian worker: obviously this is mainly a task for those who can apply themselves continuously to field work for some years at a stretch.

A considerable amount of work has been done by Puri[17] on the larger plant-remains in the Karewas. This work should be brought to completion, but at the same time it should be recognised that the pollen analysis of the Karewa Series, and of the sub-recent peat deposits of Kashmir, holds promise of even richer results for a close dating of climatic oscillations and orogenic movements in this area during the past few million years.

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INDIAN WOOL*

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ON account of its many scientific and technical aspects, wool has been a subject of close study in recent times. As a result we have a fairly good conception of the physical and chemical nature of wool, one of the oldest known protein fibres; and the knowledge has been fruitfully utilised in a number of technological developments pertaining to woollen textile industry. From the economic standpoint the quality of wool is of paramount importance to the country which has a large trade in this commodity. Assessment of wool qualities in terms which are physically definable is, therefore, necessary. This is generally done either by specific numbers or by some symbols which show a relation to the spinning quality expressed as "Counts". Ultimately, however, all such specifications which are made by the wool sorters merely by appearance and feel of the samples, are related to the absolute dimen-

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sion of the fineness of the fibres which is precisely measurable in physical terms. Laboratory methods have been, therefore, perfected and specifications drawn up to which various trade qualities of wool conform.

Indian and Foreign Wool

Of the four thousand million pounds of wool annually produced in the world, the major proportions are contributed by Australia and New Zealand (33 per cent.), and by America (25 per cent.). The European countries produce about 20 per cent., while Africa and Asia account for the rest almost equally (10 to 12 per cent.) between them.

India produces annually nearly one hundred million pounds of wool, which is 2·5 per cent. of the total world production, and is valued at fifty to sixty million rupees. Of this about half is exported, mostly for the manufacture of carpets. But, like cotton, Indian wool, in common with other Asiatic wools, is considerably coarser than those produced in other countries, notably Australia. Indian wool, consumed in this country and abroad, is useful only for coarse quality goods such as blankets, carpets, cheaper qualities of felts and as a lining material for clothings made from finer wools. Indian woollen mills, producing yarns and cloth for the worsted and clothing types of materials, mostly use foreign wools or blends of foreign and Indian wool of selected varieties from Kashmir and Tibet.

On the other hand, paradoxical as it may seem, India also produces the world's finest wool material, namely, the undercoat of fine hair of the famous Pashmina goat of the Kashmir frontier. The production of Pashmina wool is, however, extremely limited, and the question of increasing the population of this animal in its own habitat and in other parts of the country still needs a systematic investigation.

As the finer quality wools consumed by the woollen mills costing 10 million rupees and the fabric materials costing nearly 30 million rupees, are all imported the question may be asked, if it is not possible to produce better wool in this country. Before attempting to answer this question it is important to know the types of wool produced in India and their comparison with the foreign products. The following table gives the relevant information.

Fineness, Homogeneity, Medullation and Length

Fibre fineness is the main characteristic which determines the quality of wool, and it would be seen from the foregoing table that the first and second quality wools from other countries with finer fibres are much superior to Indian wools. However, as far as the fineness is concerned foreign wools of the coarser types (third and fourth qualities) are comparable with the two higher grades of Indian wool (Joria and Bikaner). Still, foreign wools with the same fineness as these two would be rated at a much higher value by the wool trader. Coarseness of the fibre is, therefore, not the only defect in Indian wool. It is the very uneven spread or distribution of the fineness, combined with what is known as medullation or hairy portion, indicated by the dead white appearance and non-resilient nature of the fibre that are responsible for the inferiority of the Indian wool. These defects result from the wild state in which the Indian sheep are allowed to breed. In the absence of selective breeding, they propagate their primitive coat of coarse hairy wool from generation to generation, without any improvement. This fibre heterogeneity and medullation are noticeable in some foreign breeds of sheep also, such as the Romney of New Zealand and the Blackface mountain sheep of Scotland, but these are rather exceptional cases, whereas in most of the Asiatic breeds both heterogeneity and medullation are common.

Commercial Classes of Wool in Various Countries

Wool type	Trade quality	Fineness (fibre diameter in microns)
INDIAN:		
(i) Joria	40's	38
(ii) Bikaner	36's	40
(iii) Low East Indian	very low below 30's	60
AUSTRALIAN:		
(i) Super combings (Merino)	80's	19
(ii) ,, clothing	70's	20
(iii) ,, cross bred	58's	26
(iv) Cross bred	46's	35
S. AFRICAN		
(i) Super combing	80's	19
(ii) Second combing	66's	21·5
(iii) Coarse merino	below 60's	Above 24
AMERICAN		
(i) Fine	80's–64's	19–22
(ii) Half blood	60's–56's	24–28
(iii) Quarter blood	50's–46's	31–35
(iv) Common bred	44's–38's	37–39
ENGLISH:		
(i) Southdown	58's–50's	26–31
(ii) Cheviot hog	44's–40's	36–38
(iii) Scotch black face	32's–28's	48–52

It would be, therefore, obvious that unlike foreign wools, specifications giving only the fibre fineness would not suffice for Indian wools. We need to have specifications for heterogeneity and medullation as well. These have to be established by suitable methods, heterogeneity by the evaluation of the co-efficient of variation in diameter from a large number of microscopic measurements on the individual fibres in a wool sample and medullation by the measurement of the medullated portions in each fibre, carried out along with the diameter measurements.

A clear idea of the position being considered would be obtained from the accompanying diagrams and photographs. Figs. 1, 2 and 3 show instances of homogeneous, moderately homogeneous and heterogeneous fibre distributions respectively in samples of shoulder wool from three different sheep. While Fig. 1 shows a uniform sample with high peak, the large variations in fineness (diameter) and the con-

sequent heterogeneity of the sample in Fig. 3 is at once apparent. Most of the Indian wool

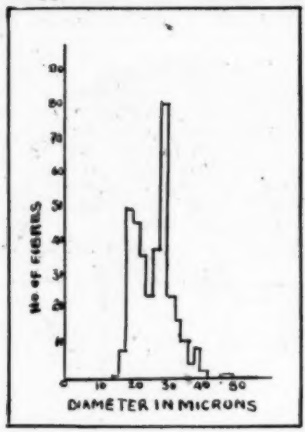


FIG. 1

is of this character, and this is conveniently shown by the corresponding value for the per-

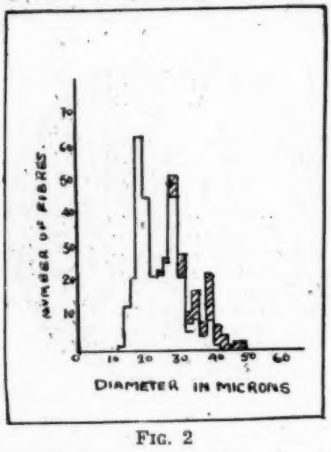


FIG. 2

centage coefficient of variation in diameter, designated as C.V. The proportion of medul-

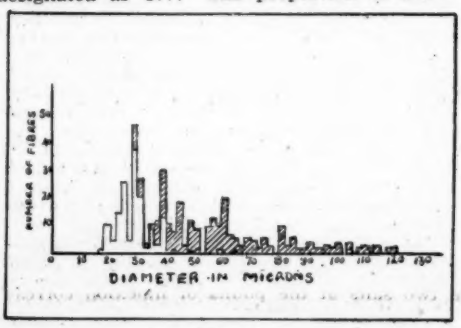


FIG. 3

lated or hairy fibres and their distribution is also shown in Figs. 2 and 3 by the shaded portions. Fine wool of Fig. 1 has no medullation. Photomicrograph in Fig. 4 shows wool fibres with clearly visible outer covering of scales. These are fine wool fibres free from medullation. The sample in Fig. 5 is a heterogeneous mixture of fine and coarse fibres. Such specimens have very high C.V. figures giving values above 50 per cent. Fig. 6 shows a very inferior type of wool, almost wholly hairy or medullated and very coarse.

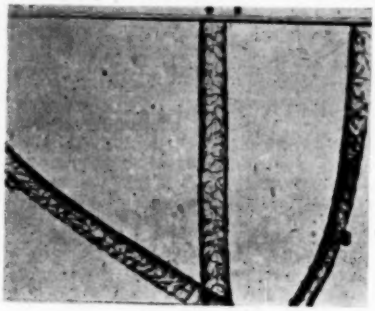


FIG. 4

Cross-sectional views of wool samples are still more helpful in arriving at an estimate of the wool quality, as all the necessary features—fineness, homogeneity and medullation—are strikingly brought out in one picture. Some

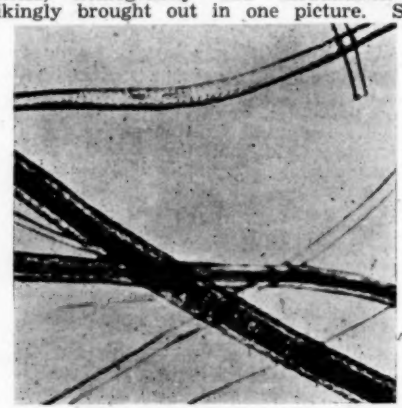


FIG. 5

typical cases are shown in photomicrograph Figs. 7 to 10. Fig. 7 is fine Merino wool, homogeneous with uniform fibre diameters and totally free from medullation. Fig. 8 shows the cross-section of a sample of Kashmir wool, coarser than Merino, but free from the defects of heterogeneity and medullation. Fig. 9 is a wool sample with none too homogeneous distribution of fibres. Medullation is marked in coarser fibres as central dark spots. Fig. 10 shows very coarse fibres—almost all hair, high-

ly medullated. As the photographs are obtained at the same magnification (× 110) the cross-

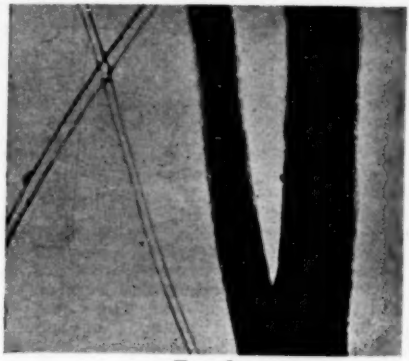


FIG. 6

sections give a good idea of the relative fineness of each type of wool. (Scale : 1 cm. = 90 microns.)

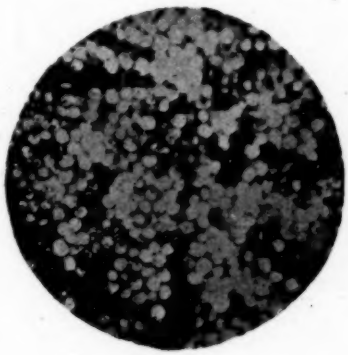


FIG. 7

A high coefficient of variation in diameter, with values above 40% and medullation above

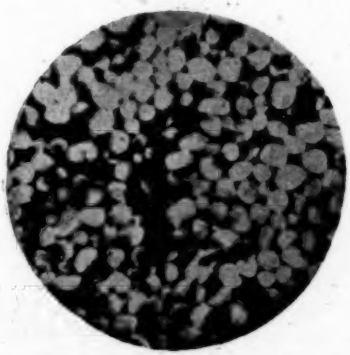


FIG. 8

30% definitely imparts a coarse and harsh feel to the wool sample under test, so much so that it is possible to lay down a quality scale of wool in accordance with the magnitude of these

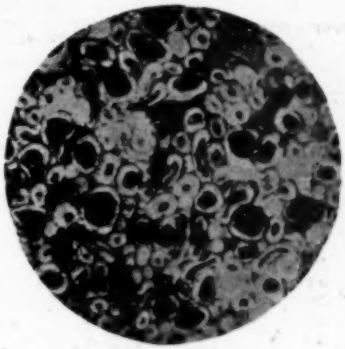


FIG. 9

defects. It would be thus apparent that assessment of any sample for its spinning qualities based solely on its average fibre fineness would lead to erroneous results, if heterogeneity and

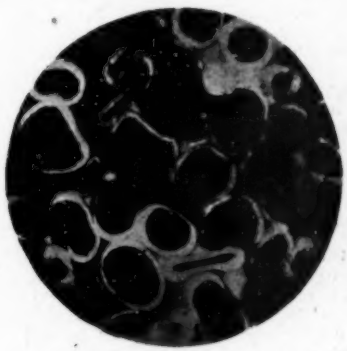


FIG. 10

medullation are left out of consideration. On the other hand with foreign wool this difficulty is not at all serious, and a direct correlation between the fibre fineness and spinning quality expressed as 'count' numbers has been laid down as shown in the following table.

The trader's specification of wool qualities is generally in terms of the count numbers mentioned here, which indicate the number of hanks, each 560 yards long, which could be spun from 1 lb. weight of wool. As the length of the yarn which could be obtained from a given weight of the fibrous material depends on the fineness of the individual fibres the practical advantage of this system of quality specification is obvious. It is similar to that adopted for cotton (840 yards in a hank). Judged from their average fibre-fineness values only the better types of commercial Indian wools like Joria and the Bikaner would hard-

ly be above the 50 count quality, though they are never assessed in these terms, for their extreme heterogeneity would considerably lower down this count values below 40.

Spinner's count	Fineness (Diameter in microns)
100	17·1
90	18·3
80	19·6
70	20·8
64	22·3
60	23·4
58	25·5
56	27·2
54	29·0
50	31·0
48	33·1
46	35·5
40	38·3
36	39·2

The length of the staple, so important for the cotton spinner, is also significant for wool as far as the manufacture of yarns for the worsted and finer clothing industries are concerned. Finer wools are generally short (2 inches), while the coarser varieties of non-medullated wool are obtainable in lengths upto 8-10 inches or more. However, for the medullated hairy type, length could be indefinite. As a matter of fact long hairy fibres are unsuitable for carpet and blanket manufacture and for this reason Indian wool with at least two shearings in a year (*Chaitra* and *Shravana*) in March (Spring) and September-October (Autumn), is not generally allowed to grow to a length of more than 3 inches. The climatic condition of the country also makes it necessary to have two shearings in a year.

Foreign Matter

Raw wool on the body of sheep is always contaminated with grease known as wool-fat, and suint or perspiration matters. Together with these natural accompaniments, vegetable matters and burrs, dirt and refuse also accumulate on the body, and are very often allowed to go to the market with the sheared wool collections. Even deliberate adulteration of dirt is resorted to in order to increase the apparent weight of wool, so that a given quantity may fetch a higher price than the non-adulterated lot. This ruse may or may not be successful but it certainly leads to heavier transportation charges and creates a bad impression in the public mind about the unclean nature of Indian wool. Such a practice together with the bad sorting for which Indian wool is known may, on the other hand, hit the producer and seller like a boomerang, for they may actually realise a higher price if it is based on what is known as the yield value, or the percentage weight of clean wool which could be obtained after it has been subjected to a thorough scouring process.

Scoured wool is seldom offered for sale, but sheep are generally washed before shearing. Even where the scouring practice is adopted the use is often made of cheap alkaline soap which tends to make wool felted and impart to it a harsh feel. In any case there is the necessity of marketing wool of any type only after its clean-scoured yield has been determined according to a standard method. The prices should then be based on: (1) the general qualities of the fibres and (2) the clean scoured yield. This procedure is followed in other countries. Reference cards are prepared for wool merchants showing at a glance the prices of each type of wool corresponding to all possible yield values. It is interesting to note in this connection that one of the progressive Indian States recently carried out an experiment on marketing well-sorted and scoured wool, which fetched a price 25 per cent. higher over the unwashed wool for the same variety, after deducting all the costs involved in the extra operations. The advantage of introducing standard methods of scouring and sorting is apparent.

Wool Production and Marketing

The annual production of wool in different parts of the country according to the 1940 figures is shown in the following table.

Annual Production of Wool in India

Area	Number of sheep (lakhs)	Annual yield of wool per sheep (greasy basis) lb.	Annual production of wool (lakh lb.)	Percentage to total production
Kashmir State ..	12·5	1·5	18·5	2·2
North-west Frontier Province including Agency and Tribal areas	8·4	3·4	28·3	3·3
Br. Baluchistan States	15·1	3·2	48·6	5·7
Sind and Khairpur State	7·8	4·0	30·9	3·6
Punjab	44·2	3·8	169·7	20·0
Punjab States ..	13·6	3·8	52·3	6·2
United Provinces and States	22·0	4·3	75·1	11·2
Rajputana States	53·2	3·1	164·5	19·3
Western India States ..	12·5	3·7	46·3	5·4
Bombay including Deccan States	21·1	1·0	21·1	2·5
Mysore State	26·0	0·85	22·1	2·6
Madras and States ..	121·9	0·56	69·4	8·2
Hyderabad State ..	59·4	0·56	34·0	4·0
Central Provinces ..	5·8	2·0	11·7	1·4
Bihar	11·5	0·81	9·3	1·1
Orissa	4·0	0·75	3·0	0·3
Bengal and States ..	5·1	1·1	6·0	0·7
Other areas	9·7	2·0	19·5	2·3
Total for India ..	453·8	1·9	850·3	(100·0)

According to their locations, several varieties of Indian wool are known in commerce such as Joria (Kathiawar), Bikaner (Punjab and Rajputana), Beawar (Rajputana), Fazlika (Punjab), Multan, Kandahar, S. Indian, etc.; and these are sold in bales roughly graded according to their appearance and feel when handled by experienced wool dealers. Feel

is, however, dependent on fibre fineness, their distribution and medullation as has been noted already ; and it would be quite possible to have only three or four grades, clearly defined on these physical attributes of the fibres, rather than the confused and uncertain classification prevalent at present.

The principal market centres of wool in India are Peshawar, Lahore, Amritsar, Fazlika, Cawnpore, Bikaner, Jodhpur, Beawar, Karachi, Jamnagar, Bombay, Ahmednagar and Bijapur. Here sales are held twice a year (May and November), and most of the wool for export trade and for local consumption in mills and cottage industries is disposed off. These sales are very often not organised on proper lines, and it is not uncommon to find the middlemen getting most of the profit and the producer the least. It would be realised that gradations according to specified standards, stamping of the goods so classified by a recognised authority and sales on well organised economic lines so that the wool producer gets the maximum of benefits, are the necessary factors to improve the unsatisfactory state of affairs found at present in the wool industry.

Sheep Breeds of India

It is likely to be presumed from what has been said about Indian wool, that this country is incapable of growing fine wool, or that there is no scope in this country for developing good breeds of sheep with fine homogeneous and non-hairy type of wool. The fine-wooled Pashmina goat of the Kashmir frontier and the very limited supply of wool it gives, has already been mentioned. Data obtained during the course of recent work on the fibre characteristics of a number of Indian sheep breeds have amply shown that sheep types producing wool comparable with the Merino quality of the 56'S to 58'S class, do exist in this country. Such breeds of sheep are found in the North Western Frontier Provinces (Hashtanagri and Khagani breeds), in the Kashmir State (Karnah and Gurez breeds), in the Punjab (Hissar dale), in certain parts of Kathiawar, Kutch and Gujarat (Pattanwali) and in the North Deccan (Deccani). However it is only by chance that a few good individuals in each of these breeds survive, for no attempt has ever been made on a large scale to improve the number of good breeds. All the rest of the Indian breeds invariably produce coarse, heterogeneous and highly medullated wool. The few individuals of the better types are always in danger of being contaminated on account of the primitive conditions of indiscriminate breeding, ignorance of the breeders and migration of the flocks to more fertile parts of the country during seasons of pasture scarcity, often involving long journeys. These factors allow sufficient scope for the mixing up of pure breeds with good wool with inferior types. Sheep-breeding farms established by the Government and some States do help to identify, isolate, conserve and breed the good types of sheep ; but they could not be expected to undertake large-scale breeding operations, which should be done under present conditions, by the wealthier class of landlords and by floating joint-stock companies. A step in this direction has been recently taken at Patan in Baroda State, where it has been found possible to produce commercially wool of good quality from the Pattanwali breed of Northern Gujarat. More efforts of this type are needed to develop and establish the good sheep breeds of the country, and make Indian wool comparable with class wool from other parts of the world.

The principal breeds of Indian sheep which have been recognised are listed in the table below, together with information on the wool fibre characteristics of some of the best individuals among them.

Sheep Breeds of India

Breed	Region	Fibre length (mm.)	Fineness (microns)	Homogeniety (C. V. in diameter)	Hairy portion (medullation %)
Karnah ..	Kashmir	87	26	22	0
Gurez ..	Kashmir	63	22	25	0
Hissardale ..	Punjab	73	24	19	0
Pattanwadi ..	Gujarat	98	30	27	0
Khagani ..	Hazara Dist.	62	33	34	0
Hashtanagri	N.W.F.P.	100	25	39	2
Deccani ..	Deccan	83	36	32	3
Lohi ..	Punjab	114	39	27	4
Masuda ..	Ajmer	33	32	31	8
Bikaner ..	Rajaputana	149	38	24	3
Damani ..	N.W.F.P.	38	35	34	18
Bibrik ..	Baluchistan	103	39	31	20
Bellary ..	Madras	103	42	36	60
Jalauni ..	Jalauni Dist. U.P.	66	69	43	58
Khasi ..	Assam	78	66	58	61

Comparing this table with the last one for commercial wools it is apparent that some of the sheep breeds at the top of the table are capable of giving fine wool of the type needed for the worsted and the clothing industry. However, although there may be a large number of animals in some or any of these breeds, those actually showing good fibre characteristics mentioned are very few. They are generally restricted to small regions or are confined to some experimental farms only, and need a hundred to thousandfold multiplication if the wool produced by them is going to be any industrial value. Thus the Hissardale breed which has been evolved by crossing the Merino and the Bikaner sheep, and which may, therefore, be called Indian Merino, has proved itself quite successful. However, its number is so limited that a large demand which exists from sheep-breeders for a supply of these animals in different parts of the country is not easily met with. The case with the good individuals from the best breeds of Kashmir is also very similar.

Improvements in Coarser Types of Wool

The experimental farms established by the Government ascertain the best conditions under which the good sheep breeds of the districts around may thrive, and undertake a programme of work, according to which inbreeding (in selected flocks) and cross-breeding (with recognised indigenous and foreign breeds) experiments are carried out with the idea of improving wool quality of known breeds and establishing new breeds with desirable fibre characteristics. The process is long, and several years may be required to increase the stock of good breeds sufficiently and to fix new types. Other genetical factors such as the best breeding season of the year and the number of

lambings in a year, have also to be considered. Whatever information is thus obtained on the good breeding of sheep is generally passed on to sheep-breeders in villages and towns for any use they could make of it.

Laboratory Analysis and Assessment of Wool

In any case, for judging the quality of wool, whether in testing the suitability of animals for particular types of experiments or in gauging the success of the experiments already undertaken or in distinguishing between the good and defective types of wools or even for trade requirements, laboratory tests for wool fibres are always necessary. Very little has been done in this respect in this country, but elsewhere definite standards and methods for the assessment of various grades of wool exist, and are recognised by the Government of the country. Accordingly, all wool for trade has to conform to standard specifications.

The most important physical characteristics of wool which determine its quality, as has already been mentioned are the length and the diameter of the fibres, considered together with the amount of individual variations in them. The latter are determined as coefficients of variations from a statistical analysis of individual fibre measurements thus giving a complete idea of the homogeneity or heterogeneity of a sample with respect to the particular characteristic measured. In some cases analysis of variance may have also to be carried out to find whether there is any correlation between the two variables of the fibres such as the length and the diameter. The variance test is also useful in ascertaining the amount of variations to be expected in the fibre characteristics of the individuals in a given breed of sheep. These methods are very helpful in arriving at suitable specifications for wool standards for different breeds of sheep and also for trade purposes in case of commercial wools.

The length is measured to the nearest millimeter by stretching the fibre on a black velvet board against a steel rule placed alongside. In a few cases where the samples have crimps, the unstretched lengths of the whole staple is measured, and the number or crimps per centimeter length calculated from the observed number of total crimps along the staple. About 500 measurements are thus carried out on one specimen, the readings being directly plotted on a sectional paper, so that at the end of an examination, the frequency distribution diagram is obtained. Mean length, standard deviation from the mean and coefficient of variation are calculated from the figures obtained.

For the fineness measurements, a bundle of about 500 fibres is cut up in very small lengths of about 0·3-0·5 mm. in a special type of microtome and a suspension of these is made up in thickened cedar wood oil. A drop of this suspension is placed on a microscopic slide and covered with a cover slip. With a microprojection apparatus the images of the fibres on the prepared slide are projected on a screen, and the width of each is measured with a transparent scale to the nearest half millimeter at least at three points along the length. The mean of these values gives the average width of a single fibre in the field of view. Several fields have to be examined in order to make up the required number of measurements. As the magnification is always maintained at 500 diameters, 1·0 cm. width of the projected fibre corresponds to a fibre diameter of 20 microns ($20\mu = 20 \times 10^{-3}$ mm.). The diameter readings which are correct to the nearest micron are plotted, as for length measurements, on a sectional paper so as to obtain a frequency distribution curve (Figs. 1, 2 and 3). From the measurements thus carried out, the mean, standard deviation and coefficient of variation are calculated.

Medullation, as has been observed before, is a property connected with coarse wool fibres and hairs of many animals. A medullated fibre may be generally distinguished from a wool fibre by its dead white appearance and non-resilient nature. A non-medullated wool fibre on the other hand is semi-transparent or translucent and possesses a good amount of elasticity. Under the microscope wool fibres appear covered with scales, while hairy or medullated fibres when freshly mounted in a non-alcoholic medium show long dark longitudinal marks in the central portion which may occur at intervals or run for the whole length of the fibre (Fig. 5).

It has been observed before that an undesirable feature of Indian wool is its high degree of medullation. One of the tasks of the Indian breeder, therefore, consists of producing wool free from medullation. A determination of the degree of medullation in a wool sample is thus important from the sheep-breeder's as well as from the commercial point of view. When the image of the wool fibres is projected on the screen for the measurements of diameter, the medullated portion in each of them is also recorded, and the percentage amount of medullation in the number of fibres measured, is calculated from the collective data obtained for any one sample.

Based fundamentally on these fibre characteristics, namely, (i) fineness, (ii) fineness homogeneity (C.V. in diameter) and medullation, it is possible to arrange various types of sheep breeds according to the quality of wool produced by them. The table on Indian Sheep Breeds has been thus prepared from the results which are known so far.

Wool Standards

From what has been said here about the Indian Wool it would be realised that the present need in this field is to know exactly the types of wool grown in this country. This has to be done for the large quantities of wool in the trade, as well as for the smaller quantities obtainable from the known pure breeds of sheep in the country. When the fibre qualities of each of these types have been established by laboratory tests, standard specifications in terms of physically measurable qualities such as length, fineness, homogeneity, hairiness may be laid down to which various grades of wool would conform. Such standards would be helpful to traders in wool as they can always rely on the specifications under which various types of wool is handled by them. Sheep breeders, on the other hand, would also gain much by the standard specifications as they would be able to judge any improvement in the qualities of wool produced by the specific sheep breeds against a system of standards.

The Indian Council of Agricultural Research through its Wool Committee is devoting its attention to the question of wool standards as well as to other neglected aspects connected with the Indian woollen industry, notably the methods of improving the production, grading and marketing of Indian wool.

SOLAR RADIATION AND THE INDIAN MONSOON*

K. S. RAMAMURTI
(*Poona*)

Introduction

THE S.W. monsoon or summer monsoon is a major event in the agricultural life of India, which has been widely studied. Malurkar[1] has described the day-to-day forecasting of the monsoon over India from its earlier activity in the Indian Ocean. The local distribution of monsoon rainfall[2] and a forecast of the seasonal rain in various homogeneous divisions of India[3] have been studied by Walker. He divided India into three homogeneous rainfall divisions, *viz.*, N.E. India comprising Assam, Bengal, Bihar and Orissa ; Peninsula comprising Gujarat, C.P., Konkan, Bombay, Deccan, Hyderabad and north Madras Coast ; and N.W. India consisting of the west U.P., Punjab, East and North, Kashmir, N.W.F.P., and Rajputana to which S.W. Punjab has been added on account of its geographical position ; but while weighting the mean rainfall with the area of each sub-division to obtain the mean for the whole of N.W. India, only half the weightage is given to S.W. Punjab. The above divisions are referred to in this paper (see Fig. below).

The chief characteristic of the pressure distributiion over India during the monsoon† is the trough of low which extends from the S.E. Punjab to the head of the Bay and the concomitant high pressure belt in the Indian Ocean. Hence a study of any feature of the monsoon should be based on this background. The low over Upper Burma is another of the summer low pressure cells.

The monsoon follows closely the movements of the sun both in its advent to the north of the equator and in its retreat thereafter.

The changes occurring in the sun such as sunspots, faculæ and flocculi have close relation to changes in the solar radiation outside the atmosphere, particularly to changes in the ultra-violet and blue end of the solar spectrum.[4] Walker found a correlation coefficient of +0·59 with a probable error of about a tenth of this value between 42 monthly mean values of sunspot numbers and solar constant.[5] He also found a correlation of + 0·64 between June—August sunspots and synchronous solar constant.[6]

Some Previous Work in the Field

Walker recorded the effect of sunspots on the annual rainfall of representative stations all over the world.[5,7] He finds the correlation of sunspots with the total annual rainfall over the plains of India as given by all the stations in existence from 1865 to 1912 to be + 0·26. Satakopan's[8] studies in the Peninsula and N.W. India led him to conclude that "the apparent positive association observed between sunspot numbers and rainfall in India by Walker and others has not been maintained during the recent spot cycles."

Clayton[4] remarks that the centres of high pressure (centres of action) are pushed to higher latitudes with increasing solar activity. They also recede farther from the nearby land areas.

Sources of Data

The daily values of the solar constant, solar energy in calories per square centimetre per minute outside the terrestrial atmosphere determined at Montezuma, Table Mountain, Mount St. Katherine and Harqua Hala are published in the *Annals of the Astrophysical Observatory of the Smithsonian Institution.* The ten-day and monthly means (preferred and improved preferred values) and their standard deviation from August 1920 to September 1939 are published in Vol. 6 of the *Annals.* The data are given in Table I.

The June to September rainfall departures[2] from 1875 to 1921 for the Peninsula and N.W. India, and the monthly departures[9] from 1875 to 1924 for May to October for the Peninsula and N.E. India and for all the months for N.W. India are published in the *Memoirs of India Meteorological Department.* For subsequent years rainfall data for monsoon season as a whole are taken from the "Statement of Actual Rainfall in the Monsoon Season, June to September", issued every year.

Correlation Coefficients

The correlation between June to September rainfall of these divisions and the mean solar constant in each of the preceding 12 months, as well as June and June to September of the same year are shown in Table II. These correlation coefficients are based on data for 19 years except for the months of August and September which are based on 20 years' data. The values of the correlation coefficient for different levels of significance and 17 degrees of freedom are taken from Fisher.[10]

* The cost of publishing this article has been met from a grant from the Indian Council of Agricultural Research.

† By 'Monsoon' is meant the S.W. monsoon in this paper.

TABLE I

Correlation of Solar Constant with Rainfall in Various Divisions of India

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1920								1·930	1·947	1·945	1·950	1·953
1921	1·957	1·955	1·949	1·947	1·950	1·939	1·950	1·943	1·950	1·955	1·957	1·952
1922	1·947	1·946	1·936	1·930	1·930	1·918	1·914	1·921	1·917	1·925	1·926	1·924
1923	1·942	1·929	1·932	1·931	1·936	1·929	1·937	1·941	1·948	1·945	1·942	1·941
1924	1·941	1·943	1·945	1·941	1·949	1·949	1·951	1·948	1·948	1·951	1·951	1·953
1925	1·949	1·955	1·949	1·948	1·947	1·948	1·949	1·948	1·949	1·945	1·946	1·948
1926*	1·946	1·941	1·942	1·939	1·941	1·943	1·942	1·944	1·945	1·939	1·936	1·939
1927	1·939	1·945	1·946	1·945	1·942	1·946	1·944	1·944	1·948	1·942	1·947	1·943
1928	1·940	1·942	1·943	1·942	1·942	1·946	1·943	1·943	1·942	1·944	1·947	1·947
1929	1·947	1·942	1·945	1·945	1·944	1·942	1·940	1·940	1·940	1·939	1·942	1·947
1930	1·943	1·944	1·943	1·943	1·948	1·948	1·947	1·947	1·947	1·946	1·948	1·951
1931	1·950	1·949	1·946	1·944	1·948	1·947	1·943	1·948	1·948	1·948	1·948	1·950
1932	1·947	1·945	1·942	1·943	1·941	1·946	1·945	1·944	1·946	1·944	1·944	1·947
1933	1·948	1·948	1·944	1·942	1·940	1·943	1·946	1·946	1·948	1·950	1·950	1·951
1934	1·950	1·946	1·947	1·946	1·946	1·949	1·949	1·948	1·948	1·952	1·950	1·950
1935	1·947	1·945	1·948	1·948	1·947	1·947	1·946	1·949	1·947	1·947	1·950	1·951
1936	1·949	1·949	1·948	1·949	1·947	1·949	1·948	1·945	1·946	1·949	1·951	1·949
1937	1·947	1·948	1·945	1·943	1·944	1·946	1·944	1·947	1·947	1·947	1·948	1·952
1938	1·950	1·949	1·950	1·945	1·944	1·945	1·945	1·945	1·947	1·949	1·951	1·951
1939	1·949	1·948	1·946	1·944	1·946	1·944	1·945	1·943	1·947			
Mean	1·947	1·946	1·945	1·943	1·944	1·943	1·944	1·943	1·945	1·945	1·947	1·947
S.D.	·004	·005	·004	·005	·005	·007	·008	·007	·007	·006	·007	·007

* Improved preferred means are given from 1926 onwards.

TABLE II

A. Correlation Coefficients

Solar Constant / Division	Preceding year												Same year	
	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	June to Sept.
North-east India	+·17	+·45	+·20	+·47	+·53	+·59	+·49	+·36	+·38	+·11	−·09	−·14	−·33	−·42
Peninsula ..	+·34	+·21	+·19	+·20	+·11	+·12	+·28	+·40	+·20	+·21	+·14	+·07	+·22	+·28
North-west India	−·21	−·05	−·05	+·02	−·02	−·13	−·07	+·08	−·01	−·17	−·21	−·17	−·16	−·08

B. Values of the Correlation Coefficient for Different Levels of Significance

P ..	·10	·05	·02	·01
C.C. ..	·3887	·4555	·5285	·5751

INFERENCE

Monsoon rain in N.E. India seems to have significant positive correlation with the solar constant of each of the months from September to December of the previous year. The rest of the coefficients do not show any significant relationship at five per cent. level of significance. The consistency of the correlation coefficients and their gradual variation month by month makes it probable that the mode of solar variation during the preceding year influences the subsequent monsoon over India. But the limited nature of the data makes these conclusions only tentative. To study the influence of the mode of solar variation on the monsoon rainfall, a polynomial with a set of constants (α, β, γ, δ, etc.) may be fitted to the solar radiation data of the year prior to the monsoon. These constants will then represent the variation of the solar energy in that year. They can be used as independent varieties and correlated with the subsequent monsoon rainfall. This technique would bring out the relationship between the trend in the solar energy and the monsoon rains.

Theoretical Consideration of the Influence of the Shift of Centres of Action on Divergence in the Equatorial Region

That atmospheric circulation increases with the increase of solar activity is indicated by the decrease of pressure in the lower and increase in the higher latitudes.[4 b] Simpson[11] discusses the change in the cloud amount with increased solar radiation. Actual data regarding the exact proportions of the increase in solar energy utilised for strengthening atmospheric circulation and lost by reflection into space by the consequent increase in cloudiness are not available. The fact that an increased atmospheric circulation is necessary for an increase in the cloud amount perhaps permits the assumption that for any given condition of circulation and cloud amount a small variation in atmospheric circulation would be proportional to the corresponding variation in solar radiation. The probable proportional variation in solar radiation is small—about 0·25 per cent.

Let A represent the total divergence—total amount of air transported—from the regions of excess insolation to the regions of deficit insolation,

s—the mean effect of insolation on divergence over unit area in excess insolation region,

S—insolation, (represented in terms of the solar constant, sunspots, etc.)

l—the difference in latitude between the mean positions of the centres of action and the latitude at which sun is overhead.

Then considering an area of unit breadth between the centres of action in the two hemispheres,

$$A \propto 2l \times s = Kls \text{ (say)} \qquad (1)$$

We may assume that during any given period (*loc. cit.*)

$\frac{dA}{dS}$ is constant.

and,

$\frac{ls}{dS}$ = a constant* (first order approximation) (2)

$$\therefore \frac{dA}{ds} = \frac{dA}{dS} \cdot \frac{dS}{ds} = \text{Constant, } \lambda \text{ say} \qquad (3)$$

Now differentiating (1) with respect to s,

$$\frac{dA}{ds} = Kl + Ks\frac{dl}{ds}$$

This reduces to $\frac{ds}{dl} = \frac{-Ks}{Kl - \lambda}$ using relation (3)

$$= \frac{-Ks}{\frac{A}{s} - \lambda} \qquad \text{by (1)}$$

$$= \frac{-Ks^2}{A - \lambda s}$$

It is evident that

$$\frac{\lambda s}{A} < 1$$

$\therefore$ Right side reduces to

$$-\frac{K}{A}s^2\left(1 - \frac{\lambda s}{A}\right)^{-1}$$

i.e.

$$-\frac{K}{A}s^2\left(1 + \frac{\lambda s}{A} + \frac{\lambda^2 s^2}{A^2} + \ldots\right)$$

which reduces to

$$\frac{ds}{dl} = -\mu_2 S^2 - \mu_3 S^3 - \mu_4 S^4 \ldots$$

* This is the assumption on which linear correlations are based,

—by (2) and assuming initial values to make the constant of integration vanish.

That is, the change in the divergence over unit area in the region of excess insolation as a result of the latitude shift in the position of the centres of action is to reduce the divergence by a quantity which is proportional to $S^2(1 - \gamma s)^{-1}$.

Therefore the combined effect of the insolation and the shift of the centres of high pressure can be represented by the equation

$$s = a_0 + a_1 S + a_2 S^2 + a_3 S^3 + \ldots.$$

(upto relevant terms), where a_2, a_3, etc., are necessarily negative.

CONCLUDING REMARKS

Solar variations from September to December have highly significant positive relationship with the subsequent monsoon rainfall in N.E. India. The Correlation Coefficients of October and November mean solar constant with the monsoon rainfall in N.E. India are significant at 2 per cent. and 1 per cent. levels respectively. This part of India is under the direct sweep of the monsoon winds, and hence rainfall there may be taken to be representative of the activity of the monsoon. The above result suggests definite relationship between the solar variations when the sun is south of the equator (the period of the southern monsoon) and the subsequent monsoon current over India. The mode of variation of the solar radiation in the different months of the preceding year seems to have influence on the monsoon. It is also suggested that a curve of higher order may be fitted with better results. Further studies are in progress.

In conclusion, mention may be made of the limitation of even the curvilinear regression. With the shift of the centres of action both in latitude and in longitude the monsoon current also gets shifted, which effect does not come under the purview of the curvilinear regression. Other accidental events, like severe volcanic erruption throwing a lot of dust particles into the stratosphere, have an influence on the incidence of rainfall by increasing the interzonal temperature gradient. The effects of these and similar causes are evidently outside the scope of the regression equation.

I am indebted to Mr. S. L. Malurkar for suggesting the problem and for going through the manuscript.

1. S. L. Malurkar, *Forecasting Weather in and near India*, 1945 (for limited circulation). 2. *Memoirs of the Indian Meteorological Department* **23**, Part II, 1922. 3. *Ibid.*, **24**, Part X, 1924. 4. (*a*) I. H. Clayton, Solar relations to Weather, 1943, *Clayton Weather Service*, 1410, Washington Street, Canton, Massachussets, U.S.A. (*b*) *Ibid.*, Table I, p. 14. 5. *Memoirs of the Indian Meteorological Department*, **21**, Part X, 1915. 6. Sir Napier Shaw *Mannual of Meteorology*, 1936, Cambridge University Press, **2**, 336. 7. *Memoirs of the Indian Meteorological Department*, 1923, **24**, Part IV. 8. Satakopan V., Sunspots and Monsoon Rainfall in India, *Curr. Sci.*, 1946 **15**, 151. 9. *Memoirs of the Indian Meteorological Department*, 1928, **25**, Part II. 10. Fisher, *Statistical Methods For Research Workers*, 19 Table V A. II. *Memoirs of the Royal Meteorological Society*, **3**, No. 21, 1928-30.

LETTERS TO THE EDITOR

ON THE SIGNIFICANCE OF THE ADDITIONAL INFORMATION OBTAINED BY THE INCLUSION OF SOME EXTRA VARIABLES IN THE DISCRIMINATION OF POPULATIONS

The object of this note is to propose tests of significance for the additional information obtained by supplementing p basic characters with q other characters in the general problem of discrimination of groups. Such problems are of importance in multivariate analysis where the informations supplied by several variates are not independent. For instance in using Fisher's discriminant function one may ask whether the discriminant function based on $p+q$ characters is significantly better than that based on p characters.

(i) *Case of* k *populations with known co-variable matrix*

Let (a_{ij}) and (β_{ij}) be the covariance matrices for p and $(p+q)$ characters with their reciprocals as (a^{ij}) and (β^{ij}). The sample sizes for the k populations are taken as $n_1, n_2, \ldots, n_k$ and the sample mean of the i-th character in the j-th population is represented by $\bar{x}_{ij}$. Defining $\bar{x}_{i.}=\Sigma n_j \bar{x}_{ij}/\Sigma n_j$ we may calculate the generalised variance between populations V_r based on r characters.

Formula	d.f.
$V_p = \sum_{i,j=1}^{p} a^{ij} \Sigma\, n_r (\bar{x}_{ir}-\bar{x}_{i.})(\bar{x}_{jr}-\bar{x}_{j.})$	$p(k-1)$
$V_{p+q} = \sum_{i,j=1}^{p+q} \beta^{ij} \Sigma\, n_r (\bar{x}_{ir}-\bar{x}_{i.})(\bar{x}_{jr}-\bar{x}_{j.})$	$(p+q)(k-1)$
$V_{p+q}-V_p =$ (difference)	$q(k-1)$

To test for difference in mean value of the p characters for the k *populations* we can use V_p as χ^2 with $p(k-1)$ degrees of freedom. To test for additional differences indicated by the q other characters we can use $V_{p+q}-V_p$ as χ^2 with $q(k-1)$ degrees of freedom. This test can be used as an approximation when the covariance matrix is not known but estimated on a large number of degrees of freedom from the pooled sum of squares and products.

(ii) *Two populations when the covariance matrix is unknown*

The covariance matrices estimated by dividing the pooled sum of squares and products by the degrees of freedom (n_1+n_2-2) are represented by (a_{ij}) and (b_{ij}) and their reciprocals by (a^{ij}) and (b^{ij}). If $d_i=\bar{x}_{i1}-\bar{x}_{i2}$, then Mahalonobis' generalised distance based on p characters is

$$D_p^2 = \sum_{i,j=1}^{p} a^{ij} d_i d_j$$

and the one based on $(p+q)$ characters is

$$D_{p+q}^2 = \sum_{i,j=1}^{p+q} b^{ij} d_i d_j$$

To test for additional information we need

compare these distances. One such comparison is given by the ratio

$$U = \frac{1+\dfrac{n_1 n_2}{(n_1+n_2)(n_1+n_2-2)} D_p^2{}_{+q}}{1+\dfrac{n_1 n_2}{(n_1+n_2)(n_1+n_2-2)} D_p^2}$$

To test the significance of U, we can use $(U-1)(n_1+n_2-p-q-1)/q$ as variance ratio with q and $(n_1+n_2-p-q-1)$ degrees of freedom. This supplies the test for judging whether the discriminant function based on $p+q$ characters is significantly better than the one based on p characters.

(iii) *The case of more than two populations and one additional variable*

Let there be k populations, p basic characters and one additional character. To find the additional information due to this we find the differences in populations as indicated by this character when those due to the first p characters are removed. Let $b_1, b_2 \ldots b_p$ be the regression coefficients of x_{p+1} on $x_1, \ldots x_p$ in which case they are calculated from the equations.

$$c_{p+1\,i} = b_1 c_{1i} + \ldots + b_p c_{pi},\ i = 1, 2, \ldots p$$

where c_{ij} is the pooled sum of products for the i-th and j-th characters. If $\bar{y}_m$ denotes the difference between the observed mean value of the $(p+1)$-th character and the mean value as predicted from the first p characters for the m-th population, then

$$\bar{y}_m = \bar{x}_{p+1\,m} - b_1 \bar{x}_{1\,m} - \ldots - b_p \bar{x}_{pm}$$

and $$\text{cov.}\,(y_m y_r) = \lambda_{mr} = \sum_i \sum_j \bar{x}_{im} \bar{x}_{jr} c^{ij}$$

where c^{ij} is an element of the matrix reciprocal to (c_{ij}), $i, j = 1, 2, \ldots p$. If (λ^{mr}) is reciprocal to (λ_{mr}) then the variance v^2 between the populations due to the $(p+1)$-th character when the part due to the first p is removed is $\frac{1}{(k-1)} \sum \sum \lambda^{mr} (y_m - \bar{y})(y_r - \bar{y})$ where $\bar{y}$ is given by $\sum \sum \lambda^{mk} (y_m + y_r - \bar{y}) = 0$. The estimate of internal variance is s^2 where

$$(n_1+n_2-p-2)\, s^2 = c_{p+1\ p+1} - \sum_{i=1}^{p} b_i c_{p+1\,i}$$

To test the above hypothesis we can use v^2/s^2 as a variance ratio with $(k-1)$ and (n_1+n_2-p-2) degrees of freedom.

(iv) *The general theory of residual canonical roots*

We can extend the above test to the case of q extra variables. The regression coefficients of the $(p+t)$-th variate on the first p are obtained from the equations

$$c_{p+t\,i} = b_{1t} c_{1i} + \ldots + b_{pt} c_{pi}\ \ i = 1, 2, \ldots p.$$

The residuals for the m-th population are given by

$$\bar{y}_{tm} = \bar{x}_{p+t,m} - \Sigma_j\, b_{jt} \bar{x}_{jm}\ \ t = 1, 2, \ldots, q.$$

The covariance matrix between the populations is given by (t_{ij}) where

$$(k-1)\, t_{ij} = \sum \sum \lambda^{rs} (\bar{y}_{ir} - \bar{y}_{i\cdot})(\bar{y}_{js} - \bar{y}_{j\cdot})$$

the λ's and $\bar{y}_{i0}$'s being same as those defined in section (iii). The intra-covariance matrix is given by (s_{ij}) where

$$(\Sigma n_i - k - p)\, s_{ij} = c_{p+i\ p+j} - \sum_{r=1}^{p} b_{ri} c_{p+j\ r}$$

To test whether the residuals differentiate between the populations we need find the significance of the latent roots of the determinantal equation

$$| t_{ij} - R s_{ij} | = 0$$

There are $q-1$ or $k-1$ (whichever is smaller) nonzero values of R satisfying the above equation. When once the nature of tests with roots of determinantal equations are set forth the above problem is simultaneously solved.

An elaborate treatment of this test together with some practical applications will be given elsewhere.

King's College,
Cambridge, C. RADHAKRISHNA RAO.
March 20, 1947.

THE KINEMATICS OF ROTATING FRAMES OF REFERENCE

I ASK leave to comment on Mr. Kamala Prasad Singh's letter[1] "A fundamental result for rotating rectangular Cartesian frames". Before considering his result and its interpretation, it is necessary to state briefly the standard kinematical results involved. The methods and notation of the vector calculus[2] are employed here for the sake of simplicity and generality.

Let F_1 and F_2 be two frames of reference, $O x_1 y_1 z_1$ and $O x_2 y_2 z_2$ having the common origin O but changing their orientations relative to each other with respect to time (t) Θ_2 being the spin of F_1 relative to F_2 at any instant. Let $\begin{Bmatrix} D_1 \\ D_2 \end{Bmatrix}$ represent the operation of differentiation with respect to t relative to the base represented by $\begin{Bmatrix} F_1 \\ F_2 \end{Bmatrix}$. Let P be a point moving relative to F_1 or F_2 or both, the vector $\overrightarrow{OP}$ being denoted by r and let $\begin{Bmatrix} V_1 \\ V_2 \end{Bmatrix}$ and $\begin{Bmatrix} a_1 \\ a_2 \end{Bmatrix}$ be the velocity and acceleration respectively of P relative to $\begin{Bmatrix} F_1 \\ F_2 \end{Bmatrix}$. Then, If A is any vector, the relation between D_1 A and D_2 A is given by the Coriolis theorem, viz.,

$$D_2 \mathbf{A} = D_1 \mathbf{A} + {}_1\boldsymbol{\Theta}_2 \times \mathbf{A} \qquad (1)$$

Since ${}_1\boldsymbol{\Theta}_2 \times {}_1\boldsymbol{\Theta}_2 = 0$;

$$D_2\,({}_1\boldsymbol{\Theta}_2) = D_1\,({}_1\boldsymbol{\Theta}_2) = {}_1\dot{\boldsymbol{\Theta}}_2 \qquad (2),$$

the overhead dot being used for simplicity and also for indicating the equivalence of D_1 and D_2 in relation to ${}_1\boldsymbol{\Theta}_2$.

Taking into account (1), (2) and the definitions $V_1 = D_1 r$, $V_2 = D_2 r$, $a_1 = D_1 (D_1 r)$, $a_2 = D_2 (D_2 r)$, we have the relations,

$$\mathbf{V}_2 = \mathbf{V}_1 + {}_1\boldsymbol{\Theta}_2 \times r \qquad (3)$$

and

$$\mathbf{a}_2 = \mathbf{a}_1 + {}_1\boldsymbol{\Theta}_2 \times (\mathbf{V}_1 + \mathbf{V}_2) + {}_1\dot{\boldsymbol{\Theta}}_2 \times r \qquad (4)$$

or

$$\mathbf{a}_2 = \mathbf{a}_1 + 2\,({}_1\boldsymbol{\Theta}_2 \times \mathbf{V}_1) + {}_1\boldsymbol{\Theta}_2 \times ({}_1\boldsymbol{\Theta}_2 \times r) + {}_1\dot{\boldsymbol{\Theta}}_2 \times r \qquad (5)$$

If, and only if ${}_1\dot{\boldsymbol{\Theta}}_2 = 0$, i.e., ${}_1\boldsymbol{\Theta}_2$ is constant, (4) and (5) become

$$\mathbf{a}_2 = \mathbf{a}_1 + {}_1\boldsymbol{\Theta}_2 \times (\mathbf{V}_1 + \mathbf{V}_2) \qquad (4'),$$

or

$$\mathbf{a}_2 = \mathbf{a}_1 + 2\,({}_1\boldsymbol{\Theta}_2 \times \mathbf{V}_1) + {}_1\boldsymbol{\Theta}_2 \times ({}_1\boldsymbol{\Theta}_2 \times r) \qquad (5')$$

In deriving the above results, it has not been assumed that the pairs of axes $\{Ox_1, Ox_2\}$, $\{Oy_1, Oy_2\}$, $\{Oz_1, Oz_2\}$ coincide at any instant, as Mr. Singh has done.

(4') implies that, When Θ_{12} is constant, the vector $a_2 - a_1$ is perpendicular to both Θ_2 and $V_1 + V_2$; Mr. Singh's letter might make a reader think that $a_2 - a_1$ is perpendicular to $V_1 + V_2$ only.

As a_1 and a_2 are the accelerations of P relative to the coinitial frames F_1 and F_2 respectively, the vector difference $a_2 - a_1$ has no kinematical significance for either P or F_1 or F_2. The vector representing the difference of the accelerations of a moving point relative to two frames is the acceleration of the origin of one frame relative to the origin of the other only when the orientations of the frames remain relatively unchanged with respect to t and when the origins move relative to each other. If the origins as well as the orientations of two frames remain fixed relative to each other with respect to t, the $\left\{\begin{matrix}\text{velocity}\\\text{acceleration}\end{matrix}\right\}$ of a point relative to any one frame would be equal to the $\left\{\begin{matrix}\text{velocity}\\\text{acceleration}\end{matrix}\right\}$ of the point relative to the other frame, and the vector difference between the $\left\{\begin{matrix}\text{velocities}\\\text{accelerations}\end{matrix}\right\}$ of the point relative to the two frames would just vanish.

Hence, it is to be feared that Mr. Singh's description of $a_2 - a_1$ as "relative acceleration" is unjustified and kinematically unsound, and that his interesting result that $a_2 - a_1$ is perpendicular to $V_1 + V_2$ is of algebraic interest only.

C. E. PENDSE.

Poona,
March 30, 1947.

1. Singh, *Curr. Sci.*, 1947, **16**, 45. 2. The cross, '×', denotes the Vector Product.

ANALYSIS OF GRAPHITE

ALTHOUGH graphite is a mineral of considerable industrial importance, literature on its chemical analysis is meagre. The most widely used methods for determining carbon contents of graphite samples are the following:—

(i) Dry combustion method in which the weighed sample is mixed with an excess of copper oxide, heated in oxygen and the carbon dioxide evolved adsorbed and weighed;

(ii) Wet combustion method in which oxidation is brought about by means of a mixture of chromic and sulphuric or phosphoric acids; and

(iii) Berthier's method in which the weighed sample is mixed with an excess of litharge (total weight known) and the loss in weight on ignition noted.

The first method gives accurate results and the second generally gives lower results but both are slow and tedious. The third method is best suited for rapid routine work.

In the course of our investigations on the concentration of South Indian Graphites[1] the need for a rapid method of analysis which leaves the gangue unaffected was keenly felt. For the determination of the fixed carbon in graphite and pencil composition, Mitchell[2] suggested strong ignition in a covered platinum dish over a Bunsen flame until constant weight was reached. Our own experiments, however, showed that while oxidation by ignition in air was more rapid in a platinum than in a silica dish, constant weight was not reached after several hours of continuous ignition. This is not surprising as graphite is practically non-combustible below 650° C.,[3] and at higher temperatures oxidation in air is very slow. Mellor[4] records that Donath and Lang had ignited graphite in a capacious Rose's crucible in an atmosphere of oxygen. Using the principle of Donath and Lang's method, the authors have carried out some analysis on South Indian graphites.

The samples of graphite for analysis were tested for carbonate and sulphide minerals. Those contaminated by carbonate and sulphide minerals were not used for this study on account of the possible sources of error that they might introduce. Complete oxidation of the carbon could be secured in thirty minutes using a platinum crucible covered with a perforated lid through which a current of dry oxygen could be maintained. The mineral matter associated with the graphite is left behind in the crucible as residue. Results of analyses by the ignition and the wet oxidation methods are given in the following table. In all cases the graphite samples were first heated to constant weight at 200-210° C.

TABLE

Estimation of Carbon in Graphite by the Ignition and Wet Oxidation Methods

Sample of Graphite	Carbon per cent.	
	Ignition method	Wet Oxidation
Godavary ..	46·0	44·3
,, ..	44·7	43·1
,, ..	35·9	34·6
,, ..	34·1	32·4
Koraput ..	34·8	33·1
,, ..	33·8	32·7

The ignition method clearly yields in all cases a higher value for carbon than the wet oxidation method. Microscopic examination of the gangue obtained by floating the samples shows that quartz is the main constituent and this is accompanied by a little felspar. The ignition method is simple and saves time, an important factor in flotation experiments.

The authors wish to thank Prof. C. Mahadevan and Dr. K. Neelakantam for their kind interest in this work.

Departments of Geology and Chemical Technology, Waltair,
June 20, 1947.

C. KARUNAKARAN.
M. NARASINGA RAO.

1. Karunakaran and Narasinga Rao, *Curr. Sci.*, 1946, **15**, 285. 2. Mitchell, *Recent Advances in Analytical Chemistry*, 1931, **2**, 196. (J. and A. Churchill, London). 3. Clarke, F. W., *The Data of Geochemistry* 1916, 326 (Govt. Printing Office Washington). 4. Mellor, *Treatise on Quantitative Inorganic Analysis*, 1938, 639 (Griffin, London).

USE OF WESTPHAL BALANCE IN SEDIMENTATION ANALYSIS

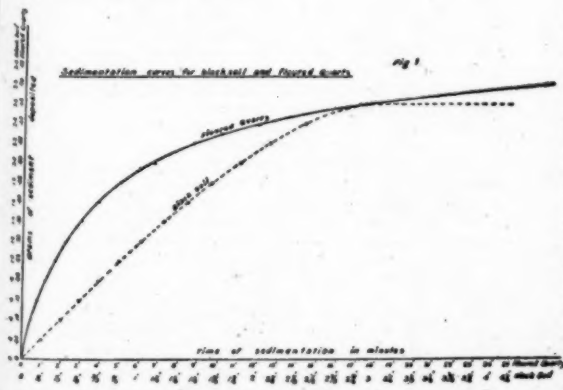
ODEN[1] devised an accurate method of soil classification on the basis of continuous particle size-distribution curves.

The author has now adapted the Westphal Balance for the mechanical analysis of soils on Oden's principle. The weighted sinker of the balance is replaced by a mica pan weighted with a steel wire at the centre. The movement of the beam, and therefore of the pan, is restricted to 2 mm. from the horizontal.

To start with the pan is kept under the pure liquid upto a known depth (20 cm.). The rider is placed immediately above the knife-edge carrying the pan. Then the balance is brought to a horizontal position with the movable weight at the other end. The rider is shifted through one division towards the central knife-edge. The liquid is carefully replaced by the soil suspension up to the same depth of the liquid, and the time taken for the beam to assume the horizontal position noted with a stop-watch. The rider is shifted rapidly through another division in the same direction, and the time taken for the beam to regain the horizontal position is again noted. This operation is repeated till the sedimentation is complete.

The shifting of the rider through equal divisions is equivalent, as in Oden's sedimentation balance, to counter-balancing with a number of weights of equal masses. The mass of sediment deposited on the pan at any given position of the rider when the beam of the balance is horizontal is given by $W = R\frac{N}{M}$ where

W = mass of sediment deposited on the pan,
N = division at which rider is at that instant,
M = number of equal divisions into which the beam, between the two knife-edges, is divided,
R = mass of rider.



The sedimentation or accumulation curves for black soil and quartz flour are thus obtained by plotting the data as illustrated in the following figure. From these the distributive curves can be derived graphically or mathematically.

A detailed paper embodying the technique and results for other samples will be published elsewhere.

In conclusion I express my thanks to Prof. C. Mahadevan for his keen interest in the work.

Department of Geology,
Andhra University,
Waltair, N. SATHAPATHI.
June 21, 1947.

1. Oden, S., *Int. Mitt. Bodenk.*, 1915, **5**, 257.

PHOTOCHEMICAL AFTER-EFFECT IN THE DECOMPOSITION OF HYDROGEN PEROXIDE BY POTASSIUM FERROCYANIDE

IT has been reported that the illumination of aqueous potassium ferrocyanide results in the formation of appreciable quantities of the aquo-salt (II), potassium aquopentacyanoferrite, and this brings about rapid decomposition of hydrogen peroxide in the dark as measured by the photochemical after-effect.[1] The photo-formation of the aquo-salt (II) from ferrocyanide is a reversible reaction. It has also been suggested that the aquo-salt (II) is in itself light-sensitive, and is decomposed by light in a short time. It undergoes slow and complicated changes on standing in the dark in the presence of air finally producing ferrocyanide, ferricyanide and ferric hydroxide. The same reactions take place on heating but relatively rapidly.

The validity of these conclusions has been experimentally tested. It has been possible to reproduce the photochemical after-effect in this reaction in the dark by using minute quantities of pure sodium aquopentacyanoferrite (II) with the unilluminated solutions of ferrocyanide. Pure aquo-salt (II) was prepared in the laboratory by the method of Hofmann,[2] and varying quantities of this substance were mixed with the usual amounts of ferrocyanide and hydrogen peroxide in the dark. The rate of decomposition so obtained is of the same order as the photochemical after-effect. It was further discovered that a minimum concentration of ferrocyanide is essential for keeping the unimolecular rate at a constant value. With lower concentrations of the ferrocyanide, the unimolecular velocity constant goes on decreasing from the beginning to the end of the decomposition. The same behaviour is observed when the ferrocyanide is not used, but decomposition of hydrogen peroxide takes place in the presence of the aquo-salt (II) alone. In the following experiments (40° C.), pure aqueous hydrogen peroxide (N/6) was used with 0·0025 gm. of the sodium aquo-salt (II) in 50 c.c. of the reaction mixture in the dark. The velocity constant, K, has been calculated by the usual equation $K = 1/t \log a/a - x$, where t represents time in minutes, a the initial concentration of hydrogen peroxide in terms of c.c.s of potassium permanganate, and x the change in time t.

TABLE I
Without Ferrocyanide

t (*minutes*)	*a*−*x*	*K*·10⁴
0	16·20	..
20	11·90	67
39	10·00	54
64	8·75	42
90	7·90	35
129	7·15	28

TABLE II
Ferrocyanide = M/1066·7

t (*minutes*)	*a*−*x*	*K*·10⁴
0	20·10	..
7	16·50	122
21	14·00	75
41	11·70	57
77	9·00	45
132	6·60	36
195	5·20	30
201	4·00	24

TABLE III
Ferrocyanide = M/533·3

t (*minutes*)	*a*−*x*	*K*·10⁴
0	19·60	..
10	15·15	112
17·5	12·75	107
42	8·05	92
62	4·65	96
90·5	2·35	102

TABLE IV
Ferrocyanide = M/320

t (*minutes*)	*a*−*x*	*K*·10⁴
0	19·10	..
7	14·10	188
17	10·30	158
41	4·40	156
64·5	1·35	179

These results show that the effect of concentration of the aquo-salt (II) is determined by the concentration of ferrocyanide in the reaction mixture. The results of experiments performed by using a constant amount of unilluminated ferrocyanide (M/320) and varying quantities of the sodium aquo-salt (II) in 50 c.c. of the reaction mixture are summarised below:—

TABLE V

Sodium aquo-Salt (gm .10⁻⁴)	K·10⁴ (Average value)
0·5	5·5
1·0	11·5
5·0	44·5
10	66·8
20	159
25	170
30	215
50	345
100	581

It is clear that the photochemical after-effect can be reproduced in the dark by suitably choosing the concentrations of the ferrocyanide and the aquo-salt (II). A complete similarity in the course of the after-effect by light and by the aquo-salt (II) added in the dark to $K_4Fe(CN)_6$-H_2O_2 mixture becomes obvious. This reaction is highly susceptible to traces of impurities, for in parallel experiments there occur sometimes variations of more than 20 per cent., which cannot be ascribed to errors in manipulation but can only be accounted for by impurities in the air of the laboratory.[3]

It was suggested by the author[4] that the primary oxidation process

$$2\,K_2Fe(CN)_5H_2O + H_2O_2 \rightarrow 2\,K_2Fe(CN)_5H_2O + 2KOH + Energy$$

is responsible, by virtue of the liberated energy, for the decomposition of a large number of hydrogen peroxide molecules. The aquo-salt (III) so formed is instantly reduced to aquo-salt (II) by the ferrocyanide and the system $Fe(CN)_5H_2O'' \rightleftharpoons Fe(CN)_5H_2O''$ continues to decompose hydrogen peroxide at a constant rate. It follows, therefore, that the aquo-ferrate (III) in the presence of ferrocyanide should be capable of reproducing almost quantitatively the results obtained with aquo-ferrite (II). This point has been fully substantiated by employing suitable concentrations of pure sodium aquo-pentacyanoferrate (III) obtained by Hofmann's method. In 50 c.c. of the reaction mixture, 0·0025 gm. of the violet aquo-salt (III) was used.

TABLE VI
Without Ferrocyanide

t (*minutes*)	*a*−*x*	*K*·10⁵
0	16·40	..
22	16·20	24
48	12·00	283
74	7·00	500
94	4·65	582

These results show that sodium aquopentacyanoferrate decomposes hydrogen peroxide in presence of ferrocyanide in the same manner as the aquo-ferrite (II). Moreover, the course of the decomposition in presence of relatively smaller amounts of ferrocyanide is similar to

that shown by sodium aquopentacyanoferrite under the same conditions. A little higher value of K in the presence of the aquo-salt (II) (Tables 2-4) as opposed to those obtained in the presence of the aquo-salt (III) (Tables 7-9) may be due to some alkali produced ini-

TABLE VII

Ferrocyanide = M/1066·7

t (*minutes*)	*a*−*x*	*K*·10⁴
0	15·05	..
11·5	12·00	86
30	9·70	64
57	7·25	56
83	5·40	54
108	4·20	50

TABLE VIII

Ferrocyanide = M/533·3

t (*minutes*)	*a*−*x*	*K*·10⁴
0	14·50	..
11	11·60	88
27	8·80	80
52	5·60	80

TABLE IX

Ferrocyanide = M/320

t (*minutes*)	*a*−*x*	*K*·10⁴
0	14·10	..
11	10·10	132
24	7·20	122
42·5	3·65	138

tially in accordance with the reaction

$$2\,K_3Fe(CN)_5H_2O + H_2O_2 \rightarrow 2\,K_2Fe(CN)_5H_2O + 2\,KOH + Energy$$

This extra alkali is not present in the reaction involving the aquo-salt (III) and ferrocyanide. The significance of the results recorded in Table 1 and 6 will be discussed later.

Experiments have also been performed by restoring in the dark in the original concentration the hydrogen peroxide decomposed in the pre-illuminated H_2O_2-$K_4Fe(CN)_6$ mixture after various time intervals from the moment of complete decomposition. It has been observed that such a mixture after complete decomposition retains for several hours the ability to decompose fresh hydrogen peroxide added in the dark in a qualitatively similar fashion as the photochemical after-effect. This behaviour, which may be called the "Secondary After-effect"[5] has been traced to the presence of unchanged potassium aquopentacyanoferrite at the end of the reaction. In the presence of air aqueous solutions of the aquo-salts (II) undergo a slow spontaneous change on standing in the dark at room temperature (35° C.) with a concomitant decrease in the reactivity as measured by the rate of hydrogen peroxide decomposition. Since the decomposition in an insolated mixture is complete in less than an hour, the activity can be detected by the addition of fresh hydrogen peroxide, and the catalyst, aquopentacyanoferrite (II), can be identified in the end solutions by characteristic colour reactions with p-nitrosodimethylaniline or nitrosobenzene. These are very sensitive reagents for the aquo-salt (II).

Fuller details will be published elsewhere.

Chemical Laboratory,
Archæological Survey of India,
Dehra Dun, B. B. LAL.
March 1, 1947.

1. Lal, B. B., *Curr. Sci.*, 1947, **16**, 118. 2. Hofman, K. A., *Annalen.*, 1900, **312**, 31. 3. Lal, B. B., *J. Indian Chem. Soc.*, 1939, **16**, 7, 323-24. 4. —— *Curr. Sci.*, *Ibid.* 5. MacMahon, P. S., and Lal, B. B., *J. Indian Chem. Soc.*, 1940, **17**, 429.

UNSAPONIFIABLE MATTER IN SHARK LIVER OILS

THE vitamin A content of Shark liver oils has been extensively studied in India. But the limits of variation of other physical and chemical characteristics of the oil are not available. The Indian pharmacopœial List[1] gives the following limits: *Acid value* ⩾ 2, *saponification value* ⩾ 200, unsaponifiable matter ⩾ 2 per cent.; and Iodine value ⩽ 90.

Forty-seven samples of genuine shark liver oil from different provinces have been analysed in this laboratory; and the data of 17 representative samples are given in Table I.

TABLE I

Chemical constants of Shark Liver Oils

	Acid value	Per cent. unsaponifiable matter	Blue value[4]
Bengal ..	0·62	2·1	30
	0·61	14·5	50
	0·60	15·0	69
	1·1	3·0	550
	2·0	8·6	40
	0·9	8·9	75
Madras ..	15·8	3·2	50
	1·2	3·9	32
	1·4	4·5	140
	1·6	2·5	34
Bombay ..	0·35	1·0	23
	6·8	1·66	176
Karachi ..	2·6	4·5	330
	0·62	6·7	380
	1·9	3·3	900
	1·4	1·5	17
Orissa ..	7·2	1·84	40

Out of seventeen samples tested, the unsaponifiable matter in 14 samples is consider-

ably higher than 2 per cent., the maximum fixed in the Indian Pharmacopœial List. Most of the values range between 3 and 7. A *lower limit of 3 and an upper limit of 7* would appear to be more reasonable for Indian oils. The N.N.R.[2] (1944) has also prescribed the limits between 3 and 6.

The unsaponifiable matter taken with the *Saponification value* and *Iodine value*, offer an important criterion for the purity of shark liver oil. The B.P.[3] permits ≤ 1·5 per cent. in cod liver oil and values between 7 and 13 for halibut liver oil. It was also found that no correlation existed between the vitamin A and unsaponifiable matter of shark liver oil.

Central Drugs Laboratory, Government of India, 110, Chittaranjan Avenue, Calcutta 12, *May* 30, 1947.

N. K. IYENGAR.
T. HOSSAIN.
B. MUKERJI.

1. Indian Pharmacopoeial List, 1946, Govt. of India Press, Civil Lines, Delhi. 2. New and Non-Official Remedies, 1944, *Amer. Pharm. Assoc., Chicago.* 3. British Pharmacopoeia, 1932, General Medical Council, London. 4. *Ibid.*, p. 596.

EFFECT OF CENTRIFUGAL SPINNING ON THE SYNERESIS OF SODIUM OLEATE GELS IN PINENE

THE kinetics of syneresis of sodium oleate gels in pinene is modified by changes in physical conditions and also by the addition of other substances.[1,2] The author has found that it is also modified considerably when these gels are subjected to centrifugal force.

Gels containing different amounts of sodium oleate in 10 c.c. of pinene, prepared in graduated glass test-tubes as described by Prasad and Hattiangdi,[3] were centrifuged at 30° C. for known intervals of time. The amount of the liquid exuded and the volume of the shrunken gel were noted. The percentage ratios of the liquid exuded to the total volume of the gel are given below.

TABLE I

Effect of centrifugal force (2,000 *r.p.m.*) *on syneresis of sodium oleate gels in pinene*

Time (minutes)	Sodium oleate in gm.			
	0·05	0·10	0·15	0·20
0	..	..	..	..
5	55	45	35	26
10	67·5	54	42·5	35
15	72	58	48	38
20	73	62·5	51	40
25	73·5	63 5	52	41
30	73·5	64	52·5	41·5

It is seen from Table I that at a given speed of the centrifuge, the amount of the liquid exuded increases with time and reaches an almost constant value after about half an hour. The facile removal of the syneretic liquid initially indicates that it exists in a free state in the interfibrillary spaces, the remaining liquid which is not exuded being enclosed in a bound state inside the micelles. Further, the amount of the liquid exuded decreases as the soap content of the gel is increased, indicating thereby that the amount of the bound liquid has increased, due evidently to the increased aggregation of the gel micelles.

The relation between the soap content and the bound liquid was found to be linear. Prasad, Hattiangdi and Wagle[4] find that no gels are formed when the soap content is less than 0·020 gm.; hence, the aforesaid straight line has no real points in the concentration range, 0-0·020 gm.

The effect of the speed of the centrifugal spin is brought out in Table II.

TABLE II

Effect of variation of centrifugal speed on syneresis of sodium oleate gels in pinene
(Concentration of sodium oleate = 0·10 gm.)

Time (minutes)	Centrifugal spin (r.p.m.)			
	0	750	1250	2000
10	0·95	2	5·5	54
15	1·3	4·5	13·5	58
25	1·9	7·5	20	63·5

It is seen that with an increase in the centrifugal speed, the amount of the liquid exuded increases, at first slowly and then rapidly. Therefore the indications are that large pressures are necessary for the removal of a major portion of the free liquid which is held by forces of attraction inside the gel system. It is probable that when very large pressures are applied some of the bound liquid could also be removed from the intermicellary spaces and exuded as a synereticum.

The author is grateful to Principal Dr. Mata Prasad for his kind interest in this investigation, and to the University of Bombay for the award of a Research Scholarship.

Chemical Laboratories, Royal Institute of Science, Bombay, *June* 23, 1947.

G. S. HATTIANGDI.

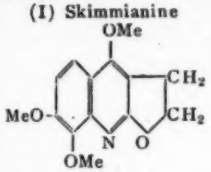
1. Prasad, Hattiangdi and Adarkar, *Proc. Indian Acad. Sci.*, 1945, **22**, 320. 2. Prasad, Hattiangdi and Mathur, *Ibid.*, 1945, **21**, 105. 3. Prasad and Hattiangdi, *Ibid.*, 1945, **21**, 1. 4. Prasad, Hattiangdi and Wagle (Communicated for publication).

ON THE ACTIVE PRINCIPLES ISOLATED FROM THE LEAVES AND THE BARK OF *SKIMMIA LAUREOLA* HOOK.

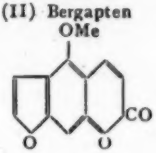
THE leaves of *Skimmia laureola* Hook, the common fodder plant of India, has been examined chemically by various workers,[1-7] and have been found to contain (1) an alkaloid-skimnianine, m.p. 176-177° (I), (2) a furocoumarin—bergapten, m.p. 188-190°, a neutral substance—skimmiol, m.p. 279-281° C., and essential oils. While isolating skimmianine from the leaves of *Skimmia laureola* for collecting an authentic sample of the alkaloid, it has been found by the authors that the leaves contain three more active principles which have not been recorded by previous workers. One of them is isopimpinellin (III), a dimethoxy furo-

coumarin (m.p. 150°; yield, 0·005 per cent.), the second one is umbelliferone (IV) (m.p. 230°; yield, 0·1 pepr cent.), and the third active principle is a neutral compound, $C_{24}H_{30}O_6$ (m.p. 258-260° C.; yield, 0·02 per cent.) which has been hitherto unknown. This neutral compound has been called laureoline.

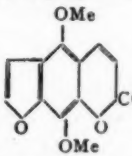
(I) Skimmianine



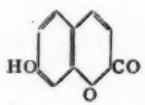
(II) Bergapten



(III) *Iso*pimpinellin



(IV) Umbelliferone



The bark of this species which has not been investigated as yet has also been studied. From the bark all the coumarins, namely, bergapten (II) (m.p. 188°; yield, 0·02 per cent.), *iso*-pimpinellin (III) (m.p. 150°; yield, 0·003 per cent.) and unbelliferone (IV) (m.p. 230°; yield, 0·05 per cent.), and the same alkaloid skimmianine (I) (m.p. 177°; yield, 0·001 per cent.) and laureoline too (m.p. 258-260°; yield, 0·01 per cent.) have been isolated in the pure state. Further work is in progress, the details of which will be published elsewhere.

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92, Upper Circular Road,
Calcutta,
June 1947.

1. Roure-Bertrand Fils, *Bull.*, **1920**, Oct. 34. 2. Schimmel, *Ber.*, 1926. Apr., 46. 3. Simonsen, *J. Soc. Chem. Ind.*, 1921, **40**, T. 126. 4. Schimmel, I. C., *Constanten*, 1923, 72. 5. Schimmel and Co-Rept., 1932, 5-73. 6. Wienhaus and Rajdhan, *J. Prakt. Chem.*, 1936, **147**, 113. 7. Chopra, Chatterjee, Dey and Ghosh, *Indian J. Med. Research*, 1938, **26**, 481.

ANTIBACTERIAL ACTIVITY OF p-AMINO-BENZENE-PHOSPHONIC ACID (PHOSPHANILIC ACID) AND ITS DERIVATIVES

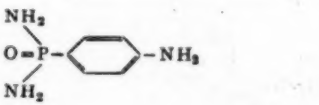
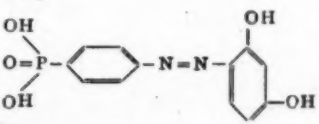
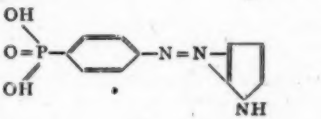
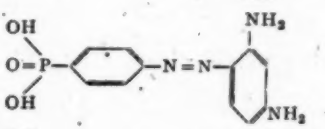
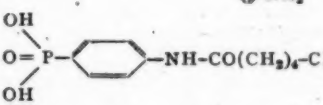
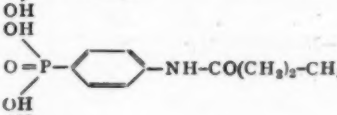
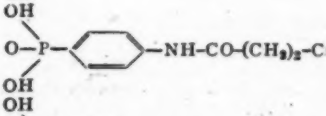
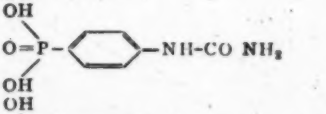
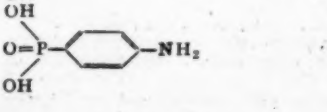
A RECENT note of Klotz and Morrison[1] describes the anti-bacterial activity of p-amino-benzene-phosphinous acid on *E. coli*. The activity was found to be slightly less than that of sulphanilamide.

Bhide and Limaye[2] prepared a number of derivatives of phosphanilic acid, whose anti-bacterial activity is briefly given in this note.

The method of testing was the Heatley cup method.[3] As the substances used were insoluble in water, their solutions in sodium bicarbonate were used. Laboratory cultures of the following organisms were used: (i) *E. coli*, (ii) *Staphilococcus aureus*, (iii) *Typhi murium* (O), (iv) *Corynebacterium xerosis* and (v) Boyd II. The results are given in Table I.

TABLE I

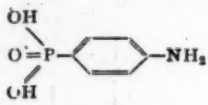
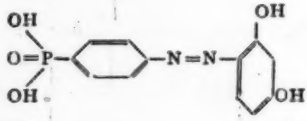
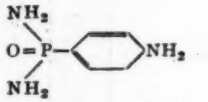
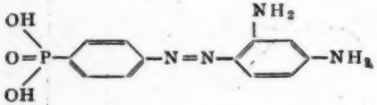
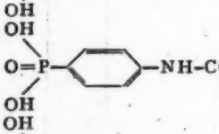
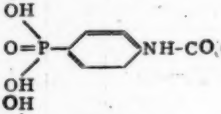
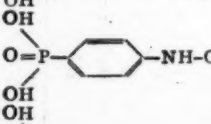
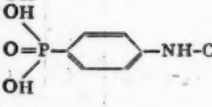
Inhibitory activity of some derivatives of Phosphanilic Acid at 1 per cent. concentration of the compound

Compound	Zone of inhibition in mms.	
	E. coli	*Staphylococcus aureus*
	5	12
	6	6
	2	0·0
	2	0·0
	1	1
	2	0·0
	4	1
	2	0·0
	No clear zone: very little growth for 12	12

Further experiments were carried out with a concentration of 0·1 per cent. Table II gives the results.

TABLE II

Inhibitory activity of some Phosphanilic Acid derivatives at 0·1 per cent. concentration of the compounds

Compound	Zone of inhibition in mms				
	E coli	*Staphylococcus aureus*	*Typhi murium*	*C. xerosis*	Boyd II
	1·0	10·0	7·0	0·0	10·0
	1·0	1·0	0·0	0·0	10·0
	..	..	7·0	0·0	0·0
	..	..	0·0	0·0	0·0
	..	..	0·0	0·0	0·0
	..	..	0·0	0·0	0·0
	..	..	1·0	0·0	0·0
	..	..	0·0	0·0	0·0

It will be seen from these tables that phosphanilamide and phosphanilic acid are active in varying degrees against *E. coli*, *Staphylococcus aureus*, and *Typhi murium* (O) in 0·1 per cent. solution. All these compounds are practically inactive against *C. xerosis*. Phosphanilic acid was found to give, in another experiment, a 5 mm. with a concentration of 0·01 per cent.

As phosphanilic acid was found to be the most active substance it was tested for bacteriostatic activity in peptone and peptone broth at various concentrations with *Typhi murium* (O), *E. coli*, *Staphylococcus aureus* and Boyd II. The following table gives the results :—

Klotz and Morrison[1] mention that Kuhn, Moller and Wendt[4] have tested the antibacterial activity of phosphanilic acid but unfortunately the details of this work have not been available to us uptil now.

TABLE III

Inhibitory activity of Phosphanilic Acid on organisms grown in peptone and peptone-broth

Organism	Concentration			Control
	1:1000	1:5000	1:10,000	
E. coli ..	+	++	+++	+++
Staphylococcus aureus	+	+	++	+++
Typhi Murium (0) ..	+	+	++	+++
Boyd II ..	±	+	++	+++

We thank Mr. H. L. Spindler and Dr. B. B. Dikshit, Dean of the B. J. Medical College, Poona, for their advice and active help and Dr. V. N. Patawardhan, Director, Nutrition Research Laboratory, Coonoor, for suggesting this problem to us.

Further work on analogous compounds containing phosphorous is in progress.

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S. P. College, Poona,
April 30, 1947.

1. Klotz and Morrison, *J. A. C. S.*, **1947**, **69**, 473. 2 Bhide and Limaye, *Proc. Ind. Sci. Congress, 34th Session*, 1947. 3. Heatley, *J. Biochem.*, **1944**, **28**, 61. 4. Kuhn, Moller and Wendt, *Ber.*, **1943**, **76**, 405.

FORMATION OF COMPLEX COMPOUNDS BETWEEN LEAD NITRATE AND ALKALI NITRATES—PART V (Magnetic Susceptibility Measurements)

The System KNO_3– $Pb(NO_3)_2$ H_2O

A SURVEY of the literature shows that there is need for a detailed study of the systems: Alkali nitrates-lead nitrate-water, with a view to obtaining evidence for the formation or otherwise of complex compounds between the two salts. The work now in progress[1] has indicated that while $NaNO_3$ shows little tendency for the formation of complex compounds, KNO_3 and NH_4NO_3 appear to give rise to at least three compounds of which only one has been known or suspected before.

We report here the results obtained from magnetic susceptibility measurements made with a modified Decker balance.[2] In this instrument, a test body, a half-inch glass rod, is rigidly attached to the centre of a thin long rod whose other end is fixed to a quartz fibre mounted to a torsion head. The readings are taken in somewhat the same manner as with the Curie-Wilson Balance.[3] The test piece hangs horizontally inside a glass tube, with inlet and outlet for introducing and withdrawing liquids, fixed in position between the poles of the electromagnet. The glass container has a jacket in which water circulates from a thermostat, and thermometers at the inlet and outlet for noting the temperature of water.

The importance of constant temperature has not been appreciated by some workers, who seem to think that because diamagnetic susceptibility is independent of temperature, there is no need for thermostatic conditions. The fact is that the equation for the calculation of susceptibility contains terms which are very much dependent upon temperature, *viz.*, the susceptibility of air and density of the liquid; and unless the temperature is kept constant we may get different values for these at different temperatures, and the diamagnetic susceptibility calculated is bound to be different under different conditions of measurement. (We are emphasizing this apparently obvious point as one of the present authors was an innocent victim of such uninformed criticism by a referee.)

A current of two amperes in the electromagnet gave the required field strength which was kept constant during each observation. The solution needed for the experiment was 25 c.c. The formula used to evaluate the susceptibility was:—

$$\chi_{soln} \cdot \rho_{soln} = \chi_\omega \rho_\omega + (\chi_\omega \rho_\omega - \chi_a \rho_a) \frac{\theta_\omega - \theta_{soln}}{\theta_a - \theta_\omega}$$

(where χ is the susceptibility, ρ density, θ the deflection, the subscripts ω, a, denote water and air).

The working of the apparatus was checked by making determinations of susceptibility of liquids of known values, taking water as reference substance with $\chi = 0{\cdot}72 \times 10^{-6}$.

The following values were obtained for benzene and acetic acid:—

	Expt.	I. C. T.
Benzene	$-0{\cdot}711$	$-0{\cdot}712$
Acetic Acid	$-0{\cdot}522$	$-0{\cdot}521$

SOLUTIONS

Molar solutions of $Pb(NO_3)_2$ and KNO_3 were prepared. 20 c.c. KNO_3 solution was made up with the requisite quantities of $Pb(NO_3)_2$ solution in a 60 c.c. measuring flask and the solution made up to the mark (60 c.c.) with water. In this way 25 solutions were made in which the concentration of alkali nitrate remained the same, namely 1/3 M, while that of $Pb(NO_3)_2$ varied systematically from 0·0 M to 2/3 M.

OBSERVATIONS

The glass rod and container are successively cleaned with chromic acid, distilled water, conductivity water and alcohol, and then allowed to dry. The readings for air and water are repeated before and after the observations are made with a set of solutions. The mean of three readings is taken for each calculation. The values of χsol are then plotted against the concentration of lead nitrate, that is, against the number of c.c. of $Pb(NO_3)_2$ added to 20 c.c. KNO_3.

The curve (Fig. 1) indicates 3 breaks at 5, 10 and 20 c.c. of $Pb(NO_3)_2$. When plottings are made with "the change of χ per c.c." the periodicity of the curve is brought out more prominently. The ratios of concentrations of the two salts at the points of inflexion correspond to the compounds:—

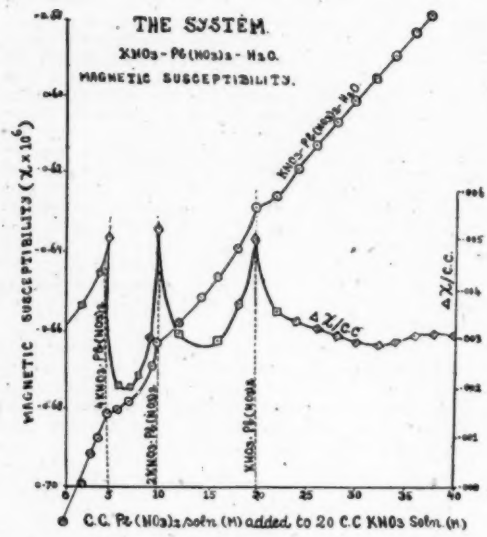

FIG. 1.

$4KNO_3 \cdot Pb(NO_3)_2$; $2KNO_3 \cdot Pb(NO_3)_2$; and $KNO_3 \cdot Pb(NO_3)_2$.

Similar experiments with the system :

$$Pb(NO_3)_2\text{-}NH_4NO_3\text{-}H_2O$$

yielded analogous results. Here also the evidence for the formation of three compounds is unequivocal, *viz.*,

$4\,NH_4NO_3 \cdot Pb(NO_3)_2$; $2\,NH_4NO_3Pb(NO_3)_2$; and $NH_4NO_3 \cdot Pb(NO_3)_2$

Thus diamagnetic susceptibility is a property which can be classed along with other physico-chemical properties like viscosity, surface tension, conductivity, freezing point, E.M.F., etc., for the investigation of complex formation in solutions.

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June 14, 1947.

1. Nayar and Pande, *Indian Sc. Cong. Abst.*, 1947, 4, 19. 2. Mathur, *Ann. der. Phys.* 1926, **79**, 324. 3. *Proc. Roy. Soc.* A, 1920, **96**, 420.

ERYTHROCYTE PYROPHOSPHATASE

Phosphatases of animal tissues. (bone, kidney, intestinal mucosa, plasma, etc.) acting on various phosphoric esters have been extensively studied but those of erythrocytes have not been investigated in detail. Roche[1] studied the distribution of such phosphatases in the red and white blood corpuscles and plasma. Jenner and Kay[2] have reported the activation of erythrocyte phosphatase magnesium. Recently the acid-phosphatase of R.B.C. was investigated by King *et al.*[3] and the erythrocyte alkaline-phosphatase is being further investigated by Patwardhan and Ranganathan.[4] But so far the pyro-phosphatase of R.B.C. has not been investigated.

The presence of pyrophosphatase in animal tissues was first demonstrated by Kay[5] and later mentioned by Roche.[1] We found that laked R.B.C. exhibit a weak pyrophosphatase activity, which is enhanced nearly hundredfold by adding Mg-ions to the reaction mixture. The enzyme shows maximum activity at the pH range of 7·6-7·9, and it shows great resemblance to the yeast pyrophosphatase.[6]

Experiment.—A measured volume of erythrocytes, washed twice at the centrifuge with normal saline, is hæmolysed and diluted with distilled water to 10 volumes. 0·5 ml. of the hæmolysate is incubated at 38° C. with 0·5 ml. sodium pyrophosphate (M/100), 0· 1 ml. MgCl$_2$ (M) and 3·9 ml. M/35 Veronal-acetate buffer (pH 7·6). After 30 minutes the reaction is stopped by adding 2·5 ml. of 10 per cent. trichloracetic acid, and filtered after 5 mins. The ortho-phosphate present in the filtrate was estimated by Fiske and Subbarow's method.[7] Wherever necessary the ortho-phosphate is precipitated as the 8-hydroxy-quinoline salt and then estimated.[8] The marked activating effect of Mg-ions on the enzyme is shown in Table I.

	Mgm. P liberated per 1 ml. R.B.C. in 30 mins.
Without added Mg	0·024
With added Mg	1·370

Thus Mg-ions which are reported to inhibit the acid-phosphatase of R.B.C.[8] and activate the alkaline phosphatase of the R.B.C.[2] activate the erythrocyte pyrophosphatase to a very great extent. With 0·001 M. concentration of Mg (qMg 3) the activation is almost nil, but 50 per cent. activation is obtained with 0·005 M. Mg (qMg 2·3) and 70 per cent. with 0·01 M. (qMg 2) and 100 per cent. with 0·05 M. Mg (qMg 1·3).

Plasma shows very weak pyrophosphatase activity even in the presence of Mg. The erythrocyte pyrophosphatase of sheep's blood is much weaker than that of human blood. As in the case of erythrocyte alkaline phosphatase such differences may be a characteristic of the species.

Further work on the properties and purification of the enzyme and its variation in health and disease will be published elsewhere.

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Dept. of Biochemistry,
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Vizagapatam,
May 8, 1947.

1. J. Roche, *Biochem. J.* 1931, **25**, 1724. 2. H. D. Jenner and H. D. Kay, *J. Biol. Chem.*, 1931, **93**, 733. 3. E. J. King, *et al.*, *Biochem. J.*, 1945, **39**, XXIV. 4. Patwardhan and Ranganadhan, *Curr. Sci.*, 1947, **16**, 59. 5. H. D. Kay, *Biochem. J.*, 1928, **22**, 1446. 6. K. Bailey and E. C. Webb, *Biochem. J.*, 1944, **38**, 394. 7. Fiske and Subba Row, *J. Biol. Chem.*, 1925, **66**, 375. 8. F. J. King and G. E. Delory, *Biochem. J.*, 1937, **31**, 2046.

ANTISEPTIC CULTURE OF RAGI (*ELEUCINE COROCANA*) SEEDLINGS AND THEIR RESPONSE TO VITAMINS

In connection with our studies on the effect of vitamins and amino acids on the growth of seedlings and excised root tips, Ragi (*Eleucine corocana*), a highly nutritious millet and staple food in Mysore, was chosen as the experimental material.

Aseptic culture of seedlings and roots was an essential prerequisite for these experiments. The method of sterilisation as advocated in literature using various chemicals such as mercuric chloride, bromine water, calcium hypochlorite, etc., proved unreliable and unsatisfactory.

The micro-crevices of the rough testa offer an ideal lodging place for the bacterial spores; the waxy coating of the testa and of the associated spores resist wetting and prevent an effective sterilisation of the seed coat. Pretreatment of seeds with a fat solvent, *e.g.*, ether, would render the testa wettable and facilitate the sterilising action of the antiseptic.

Optimum conditions of treatment were experimentally determined as follows:—The seeds (*Eleucine corocana*) were treated in the following order:—

(1) With tap water by rubbing them between fingers; next with distilled water. This helps removal of extraneous matter.
(2) Twice with 5 ml. portions of absolute alcohol, each wash lasting 5 minutes to remove the water and facilitate dissolution of fat or wax.
(3) Quickly with ether (5 ml.) to eliminate the waxy coating rendering testa readily wettable.
(4) With sterile water to remove ether.
(5) With 5 ml. of hypochlorite solution for 30 minutes.
(6) With sterile water to ensure removal of all traces of hypochlorite at this stage. A few seeds (sample I) for testing were transferred with a pair of sterile forceps into sterile petri dishes furnished with sterile filter sheets moistened with nutrient solution.

Treatment with hypochlorite for 30 minutes (1 hour in the final treatment) and washing with water was repeated seven times, and after each treatment a portion of the sample was tested for sterility.

All the seven samples were grown for five days. The rate of growth and degree of sterility are tabulated below (Table I).

Samples 1, 2 and 3 are not completely sterile, but the 4th, 5th and 6th samples are. The roots of the 7th sample soon turn brown and eventually die. The 4th sample shows quickened germination and the most lush growth. Thus the optimum conditions for aseptic cultures seem to be a minimum for treatments with hypochlorite with alternating washing. But this schedule may not be universally applicable, as the nature and susceptibility of the seed coat, the resistability of the endosperm and the activity of the antiseptic naturally differ from sample to sample.

Such excised sterile roots from petri dishes were then cultured at 28° C. for five days in tubes containing 5 ml. each of the following media:—Complete medium, basal medium, -glycine, -thiamin, -pyridoxin and -nicotinic acid media. The response in each case is shown in Table II.

TABLE I

Growth on	Sample I	Sample II	Sample III	Sample IV	Sample V	Sample VI	Sample VII
2nd day ..	—	—	+	+	+	+	+
3rd day ..	+	+	++	++	++	++	++
4th day ..	+	+	+++	+++	+++	+++	++
5th day ..	+	+	++++	++++	++++	++++	++
Degree of Infection	100·0	100·0	50·0	0·0	0·0	0·0	0·0

TABLE II

Growth of excised roots in different media

Media used	Complete medium (B.M. + B_1 + B_6 + glycine + Niacin)	Basal medium (sucrose + salts)	—glycine	— thiamin	— pyridoxin	—nicotinic acid
Percentage of increase in length after 5 days	41·66	66·66	46·1	66·66	61·6	41·6
Average increase/root in length	3·0 m.m.	5·25 m m.	4·5 m.m.	5·25 m m.	3·3 m.m.	2·8 m.m.

As seen from the table the excised roots of Ragi seedlings can grow well in a basal medium of sucrose and inorganic salts. Since they can synthesise their own vitamins, they do not require an external supply of any of the vitamins tested. This observation also explains

why Ragi can flourish in soils where many other plants cannot thrive.

My thanks are due to Mr. M. Sreenivasaya for guidance in these studies.

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June 13, 1947.

AEROBIC SPORE-FORMING BACTERIA IN BOILED MILK

GROUPS of aerobic spore-formers in milk have been described by foreign workers.[1-4] Since milk is generally boiled in India a knowledge of the distribution and characteristics of the aerobic spore-formers present in indigenous samples of milk is of practical importance. In the course of studies on organisms associated with spoilage of boiled milk, the authors have isolated and studied the characteristics of a number of strains of aerobic spore-formers from samples of milk collected from various sources.[5] The most frequently occurring strains mainly responsible for the deterioration of boiled milk seems to fall under four distinct types.

The organisms included under the first three types are mesophiles with their optimum temperature at 40°-45° C., and maximum at 55° C. They are gram positive, highly motile rods forming central to sub-terminal oval spores; they are able to utilize nitrate as a source of nitrogen and produce ammonia both from peptone and nitrate broths; they ferment dextrose and sucrose with the production of acid but no gas. Indol is not formed by any of them. On the basis of its morphology, characteristic growth in laboratory media and action on milk the first type bears a close resemblance to *B. subtilis* Cohn., except for its inability to ferment maltose and hydrolyse starch and its higher optimum temperature, *viz.*, 45° C. It does not produce acetyl-methyl-carbinol in glucose phosphate water, but it is actively proteolytic, turning milk alkaline and peptonising it within 24 hours, often without showing any apparent signs of curdling. The change is sometimes detected only after close examination. The second type resembles *B. cereus*, Frankland, in most respects. It ferments maltose but does not produce acetyl-methyl-carbinol; and starch hydrolysis is slight or doubtful. Milk is curdled and proteolysed by it within 24 hours; and the curd is completely peptonised in three days. The third type, which is a lactose-fermenter, corresponds to *B. albolactis* Migula. It ferments maltose and also produces acetyl-methyl-carbinol, but starch is not hydrolysed to any appreciable extent. It forms a firm acid curd with slight whey formation within 24 hours at 27°-30° C. and thereafter the curd is slowly proteolysed. When growing in boiled milk the proteolysis is more rapid.

The fourth type appears to be an obligate thermophile with its optimum at 60°-63° C. and growth range extending from 50° to 80° C. It is a gram negative and sluggishly-motile rod forming terminal, ellipsoid to cylindrical spores. It reduces nitrates to nitrites; produces ammonia only from peptone broth, and does not form indol or acetyl-methyl-carbinol. It ferments dextrose, sucrose, salicin and sorbite but not maltose or lactose, and hydrolyses starch. It resembles *B. kaustophilus* Pricket, except in its reaction to Gram's stain. This type is comparatively less frequent and does not grow at ordinary temperatures. When boiled milk is kept at elevated temperatures (above 50° C.) it can grow well, slowly peptonising the milk, and when the temperature is near its optimum (60°-65° C.) a rennet curd is produced in 24 hours which is gradually digested.

The heat resistance shown by the above organisms even in broth and milk cultures (which are expected to contain only vegetative forms) appears to be remarkably high. The organisms of Type I are killed only after boiling for 10 minutes, and of types II and III after half an hour. But Type IV survives all these treatments. When pH is brought down to 6·0 by the addition of lactic acid, Types I, II and IV are killed by boiling for 5 minutes, but Type II survives even boiling for 10 minutes, and curdles milk in 24 hours. After they are grown in milk for 4 hours in association with pure cultures of organisms like *B. coli*, *S. lactis*, and *L. bulgaricus*, only Types I and III survive boiling for 10 minutes.

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July 12, 1947. H. LAXMINARAYANA.

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IS THE MACRONUCLEUS OF CILIATES ENDOPOLYPLOID?

ENDOPOLYPLOIDY was recently demonstrated in fermenting yeast cells.[1] The question arose whether, in spite of the different evolutionary origins of yeasts[2] and Protozoa, similar phenomena occur in other unicellular organisms? Since endopolyploid nuclei usually have no genetical future at all, one is naturally attracted to the macronucleus of Ciliates, which has been supposed to subserve a purely physiological function.[3,4]

The macronucleus takes its origin from the micronucleus and its nuclear nature itself is inferred only because of its above origin. It divides at every vegetative division, usually by amitosis, and disintegrates after a varying number of divisions, being regenerated either by endomixis or by division of the synkarion after conjugation.

It is this necessity for the renewal of the macronucleus from time to time that has led to the supposition that it controls the physiological functions. Sonneborn[4] concludes that while the macronucleus is essential and indispensable since it controls the physiological activities of the cell, the micronucleus could be lost with impunity.

Though the structure and behaviour of the macronucleus has attracted considerable attention, Protozoologists do not seem to have cared to consider whether it is endoploid. Long

before the discovery of endopolyploidy, Wenyon[3] describes a great increase in the number of granules, assumed to be chromatin, during division of the macronucleus and remarks that "there must have taken place a remarkable increase in the chromatin during its formation and growth from the micronucleus from which it was originally derived" (p. 61).

In his very interesting paper on "Gene Action in Paramoecium", Sonneborn[4] describes the compound nature of the macronucleus without realizing that the description is typical of endopolyploidy. He says: "As set forth above, the macronucleus arises from the syncaryon as a simple diploid nucleus. It then grows enormously, becoming a multiple nucleus containing at least 30 units, each with a complete diploid set of genes ... At times of fertilization, the compound macronucleus falls apart into its component units and these are resorbed in the cytoplasm" (pp. 216-17).

There are some other interesting observations by Sonneborn confirming its endopolyploid nature. The fragments of the macronucleus undergo a fourfold increase while the new macronucleus is developing into a compound structure and it appears that the division of the new macronuclei could be suppressed experimentally. As a result individuals are produced with no macronuclei at all at the end of the second post-zygotic division. In such cases Sonneborn observed the passive distribution of the pieces of the old macronucleus during vegetative divisions. These instead of getting resorbed, develop into compound nuclei and thus at the end of a number of divisions each Ciliate comes to have only a single macronucleus.

It appears likely that the chromatin granules seen inside the macronucleus may be the heterochromatin[5] and using these as indicators—as done by Geitler[6]—it may even be possible in favourable material to study not only the variations in the degree of endopolyplody during the growth of the macronucleus to its adult size, but also after vegetative divisions.

Endopolyploidy in the yeast, therefore, does not appear to be an exception to the general rule among unicellular organisms. The significance of endomixis has baffled investigators up till the present day. But the moment one accepts that the macronucleus is endopolyploid not only does its important role in the physiological control of the activities of the cells becomes clear, but offers also an explanation as to why it should be regenerated from time to time. The usual fate of endopolyploid nuclei is death and disintegration after varying periods of activity. Hence the necessity for regeneration.

I am very grateful to Sir J. C. Ghosh, Kt., D.Sc., F.N.I., for his active interest and encouragement and the Council of the National Institute of Sciences of India for the award of an Imperial Chemical Industries Research Fellowship.

Dept. of General Chemistry,
Indian Institute of Science,
Bangalore (S. India),
June 20, 1947. M. K. Subramaniam.

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A NOTE ON THE CHROMOSOME NUMBER IN *COLOCASIA ANTIQUORUM* SCHOTT.

The reports of the chromosome number of *Colocasia antiquorum* Schott are conflicting. The diploid number was found to be 42 by Nakajima[1] and Janaki Ammal[2] and 28 by Asana and Sutaria.[3] Maeda[4] found $n = 14$.

The diploid number in a local variety, determined by me, is 36 (Fig. 1). Root-tips obtained from sprouting tubers were fixed in CrAF and stained with Genetian violet. As the drawing shows, chromosomes tend to be arranged in pairs, a form of 'somatic pairing' more marked at the periphery than at the centre.

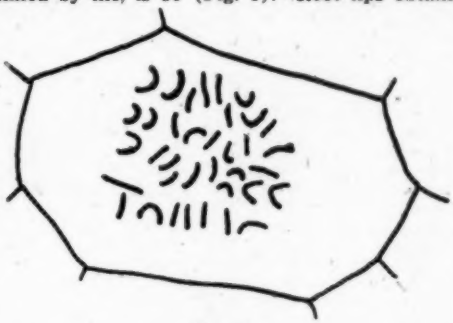

Fig. 1

Somatic pairing was first reported by Metz[5] in Diptera. Robertson[6] showed in *Paratettix* that somatic pairing occurred in diploid tissue of parthenogenetic individuals. In plants somatic pairing is reported in autopolyploids, as in *Iberis*[7] and *Cicer*.[8] The inference is that this *Colocasia* variety is an autopolyploid, and chromosome pairs are strictly homologous.

In vegetatively propagated plants polyploids and aneuploids tend to be preserved as races and varieties. The chromosome numbers reported by Nakajima and Janaki Ammal are multiples of 6. It is therefore probable that the variety with which these authors worked is a higher polyploid with the basic number 6. The material of Asana and Sutaria, and Maeda ppears to be neuploid.

I am thankful to Mr. S. Sampath for initiating the work and to Mr. K. Das for helping me in preparing this note for the press.

College of Agricultural Research,
Benares Hindu University,
Benares, N. Satyanarayana Rao.
June 16, 1947.

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REVIEWS

Hydraulic Measurements. By Herbert Addison. (Chapman & Hall Ltd., London), 1946. Second Edition, Revised. Pp. xii + 327. 158 diagrams. Price 21*sh.* net.

Just at a time when conservation of water and its multiple uses are engaging the special attention of engineers, the reappearance of *Hydraulic Measurements* in its second and revised edition is most welcome. It is an excellent reference book both to the Hydraulic Engineer and the Hydraulic Research worker. It is logically classified and arranged in such a way that it amply fulfils its avowed purpose, *viz.*, "to guide the reader quickly to the chapter wherein he may find methods likely to suit specific circumstances".

The first five chapters deal with the methods of measurement of fundamental units like Head, Pressure, Depth, Weight, Volume and Velocity, and the next seven with the measurement of the derived unit of discharge under varying conditions of engineering practice with a progressive increase in the quantities of flow. Chapter VI shows methods applicable to liquids flowing uniformly under atmospheric pressure and involving a drop in the level after passing through the measuring apparatus, like orifices and weirs. Chapters VII, VIII and IX deal with methods for flows under pressure along a closed pipe or conduit and include (i) quantity meters used in water-supply systems, (ii) Rate-of-Flow meters like Venturi and Pitot tubes, and (iii) special methods like Gibson's apparatus for Hydraulic turbines, Allen salt-velocity method, etc. Chapters X, XI and XII describe methods of gauging large streams and rivers by means of (1) free-flow methods like floats, current meters, etc., (2) artificial control sections like weirs and flumes and (3) regulating sluices in dams, barrages, etc., and by scale models. The final chapter is devoted to indicating, recording and integrating instruments for flow measuring installations.

From the point of view of facility of reference, we welcome the idea of putting the number of sections at the top of the page. To further increase this facility, we would suggest that to the section the number of the chapter also may be added, as *e.g.*, V § 84. Reference to figures may also show reference to the page on which they are found: *e.g.*, on page 185 a reference to Fig. 148 would have been quicker if page 285 were also mentioned along with it. In addition to subject index, an author index will also be useful.

As a reference book like this is to be comprehensive, it is suggested that the next edition may include the following:—

(1) Discharge over oblique weirs across rivers (anicuts in India);
(2) Discharge through Siphon Spillways (Saddle and Volute types) which are becoming increasingly used in India; and
(3) Automatic modules in irrigation distribution systems for giving constant discharge in spite of a limited range of variation in the head up-stream of the modules.

As the author admits in the Preface that there is bound to be a large divergence of opinion regarding the various appliances and methods of measurement, it is not proposed to give any opinion on this aspect. There is, however one point that I feel ought to be mentioned in view of its growing importance regarding the interpretation of results of model tests. On page 280, section 226 (iv), referring to round-crested weirs, it is mentioned that "comparative experiments have suggested that models of Ogee weirs have coefficients *greater* than those of the prototypes". The experiments in Poona (Indian Waterways Experiment Station) have indicated that the coefficients of scale models are actually smaller and a method is almost evolved to assess the coefficient of the prototype by extrapolation from the results of experiments on different scale models. As against this the experiments in Madras (Irrigation Research Station) and in our own laboratories (Hyderabad Engineering Research Labs.) seem to indicate that there is no large difference between coefficients of different scale models. In view of its importance this matter may be dealt with more fully in the next edition.

The bibliograhy is very useful. I think that there are quite a number of publications in India, specially of the Central Board of Irrigation, which may be usefully included in the bibliography.

In the introductory para (1) in defining the scope of the book, the measurement of velocity is omitted, which apparently must be a slip.

S. P. RAJU.

John Couch Adams and the Discovery of Neptune. By Sir Harold Spencer Jones. (Cambridge University Press.) Pp. 43. Price 2/- net.

The discovery of Neptune in 1846 is a story familiar to all students of astronomy and general science. The controversy regarding the priority of its discovery assumed almost international importance involving British astronomers on one side and the French on the other. Neptune was discovered independently by Adams in England and Le Verrier in France, in the sense that both accurately predicted the existence of the unknown planet and calculated its position, which later led to its identification. The claim for priority on behalf of the British scientist is that in point of date of working out the mathematics the credit should go to Adams, while the French claim refers to the date of announcement. The arbitration of Sir Roger deCoverly is most apt here, namely, that "much might be said on both sides".

Following the story in detail, however, does not bring a feeling of relief to any research student working under the conditions that Adams did. The latter was a victim of British

red-tape, conventions and formalities. It won't do if you have made a great discovery; you must also have a patron who would do the propaganda for you. Adams's important discovery did not get timely recognition, because, in the chain of circumstances operating against him, an attendant in the Royal Astronomer's household did not convey the proper message. Adams had to go away from the "Royal" door because the Astronomer Royal was either absent or at dinner. The Astronomer would not take Adams's paper seriously because he had received no reply to his letter containing some test questions. Poor Adams did not of course know that his fate was hanging on that reply. The Astronomer Royal began to take an interest in the subject only when he saw Le Verrie's article in the *Comptes Rendus*. Then the pendulum of "cussedness" swung from the Astronomer Royal to Challis, Adams's own Professor, who was entrusted with the very important work of exploring the sky for the unknown planet. The Professor took his work too leisurely for the world to wait for his convenience and narrowly missed the discovery more than once until the Berlin Observatory announced the important result far ahead of Cambridge. One cannot help feeling that Adams's own Professor let him down. That, however, is for the reader to judge.

We have in this pamphlet, presumably prepared as a centenary souvenir, a recapitulation and an authentic account of the circumstances leading to the discovery of Neptune and the subsequent controversy regarding the priority of discovery, illustrated with reproductions in facsimile of Adams's memoranda and a portrait. This account should serve as a constant reminder both to the research worker and his professor as to their respective responsibilities.

M. R. N.

Atomic Energy in Cosmic and Human Life. By G. Gamow. (Cambridge University Press.) Pp. xii + 161. Price 7*sh.* 6*d.*

This book is divided into three parts. In the first part, the author starts from the general ideas of atoms, molecules, etc., and develops the present-day views on the structure of atomic nuclei and atomic disintegration. The possibilities of the release of energy in nuclear processes and the conditions that must be fulfilled are most clearly brought out. This is followed by the second part in which the way in which stars use atomic energy is very clearly explained. In the last part, the possibilities of man using atomic energy are discussed.

The printing and get-up of the book is excellent and it is profusely illustrated with photographs, figures and sketches. The book is entirely descriptive in nature, and the attempts to explain mathematical ideas in a purely descriptive manner are admirably successful. Prof. Gamow has already made a name for himself in this direction, and the reviewer need not comment on this any further.

This is certainly one of the finest books on the subject available in the market. Students of chemistry need to know a good bit of nuclear phenomena, and this book is a real boon to them. The book can also be recommended as a text-book to B.Sc. physics students who cannot devote the necessary time to study more advanced literature.

S. V. Chandrasekhar Aiya.

Science in Industry. By A. M. Low. (Oxford University Press), 1947. Pp. 173. Price Rs. 2.

This book is the revised edition of the popular volume first published in 1939. The book gives a concise and lucid account of the peaceful applications of science. Beginning with the definition and correct exposition of Mass Production in modern industry the author describes the part science plays in the production of the most common and indispensable necessities of civilised life like food, transport, sanitation, entertainment and health. He has rightly exposed the fallacy commonly entertained against mass production; and the whole book is a powerful argument against the incrimination of science as the cause of war. In the author's own words, "the book shows how science enters into every phase of industry and how, whether we like it or not, we are dependent upon science during every minute of every day. To talk of 'abolishing' science or even controlling it is ridiculous. You cannot control or abolish a method of thought. What we can and must do is to control the manner in which scientific discoveries are used."

The value of the book for the general reader, the reviewer feels, would have been enhanced if the place of scientific research and unceasing investigation in modern industry had been illustrated in suitable places. It would keep the common citizen alive to the necessity of research in this age of democracy. The book is strongly recommended for students and the general public.

K. S. R.

Science Progress, Vol. 135, No. 138, April 1947. (Edward Arnold & Co., London), 7/6*d* net.

The current issue of this periodical contains original articles of interest in Geology, Stellar Physics, Pharmacology and Modern Algebra. Reviews and resumé of certain recent advances in general Physics and Biochemistry as well as in Botany, Plant Physiology and Entomology are included. Essay Reviews on *Binocular Matching* and *A New Organic Chemical Notation*, and reviews of recent science publications are, as usual, interesting features of the Journal.

PUBLICATIONS RECEIVED

Scientific Institutions, Societies and Research Workers in the Netherlands Indies. (Copies can be had free of cost from the Editor, *Chronica Botanica*, P.O. Box 151, Waltham 54, Mass., U.S.A.)

Fuel Abstracts, New Series, Vol. I, No. 1, January 1947. (Compiled by the Intelligence Section, Fuel Research Station, E. Greenwich, London, S.E. 10.)

Fisheries Byeproduct Industries; Dermestes vulpinus F., *an Insect Pest on Dried Fish*; *Decomposition and Putrefaction of Fish.*—Lectures delivered by Dr. S. T. Moses, Director of Fisheries, Baroda.

Science, the Endless Frontier. By Vannevar Bush, Director, O.S.R.D., Washington.

SCIENCE NOTES AND NEWS

TECHNOLOGICAL STUDIES

The Government of India have set up an All-India Council for Technical Education to promote and co-ordinate technique. In order to attain a uniformly high standard of education and examination throughout the country the All-India Council has established six All-India Boards of Technical Studies in the following main branches of engineering and technology; Engineering and Metallurgy; Architecture and Regional Planning; Chemical Engineering and Chemical Technology; Textile Technology; Applied Art; Commerce and Business Administration.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

The Government of India have decided to continue the existing constitutiton for the Council of Scientific and Industrial Research in view of the unanimous opinion of the members representing industry and science on that body. They have also decided to abolish from April 1, 1947, the Industrial Research Utilisation Committee which was an advisory body to assist the Council.

INDIAN INSTITUTE OF SCIENCE

Sir Ardeshir Dalal has been unanimously elected President of the Court of the Indian Institute of Science for 1947-48 in place of Sir M. Visvesvaraya who resigned from the presidentship of the Court owing to reasons of health.

REPORT OF PANEL ON COIR INDUSTRY

A drive for the improvement and expansion of coconut cultivation and for stepping up the production of coir in India is urged by the Panel appointed by the Central Government in respect of coir, rope, cordage and other fibre industries.

A target production of 229,125 tons of coir is specified by the Panel who suggest improved and mechanical methods in the retting of husks, proper grading of fibre and better communications in the coconut-producing areas. Coir can be easily impregnated with bituminatious and resinous materials, which provides a unique opportunity for exploiting its uses in many directions. The Panel emphasise that India should make fuller use of the raw material by retting all available husks and by establishing roperies in Travancore, Cochin, Malabar and Bombay so as to absorb more coir. The need for the establishment of Coir Textile Institute, preferably a co-operative organization of all producers in close association with Government, is also stressed.

The Panel recommend steps for growing sisal in India and duty-free import of manila and sisal fibres, a tariff on imported rope, financial assistance to the industry for research purposes and a reduction in the tariffs imposed by countries importing coir mats and matting.

PRODUCTION OF MANGANESE IN INDIA

A new process which will enable India to extract manganese directly out of her own stocks of manganese ore, of which she is the second biggest producer in the world, is described in the March issue of the *Journal of Scientific and Industrial Research*. The process which is worked out in the laboratories of the Indian Standard Metal Company, Ltd., Bombay, enables the extraction of the metal from ores and also electrolysis of Aqueous solutions to produce pure manganese.

VITAMINS FROM INDIGENOUS SOURCES

The Committee of the Technical Panel of the Food Department of the Government of India for the planning of vitamin production, has recently examined the question of the preparation of concentrates of vitamin A from shark liver oil, carotene from carrots, grasses and green leaves and vitamin C from common Indian fruits like *amla* and guava. It has suggested that vitamin C from such cheap sources as *amla* might be produced in the form of syrup taking care to preserve the vitamin content, and recommended that a certain proportion of edible oils and fats, provided they are not used for frying, could be fortified with carotene. These fortified oils could with advantage be given to the "Vulnerable sections" of the population.

CERAMIC INDUSTRY IN HYDERABAD

The Nizam's Government have sanctioned a scheme designed to develop ceramic industry at a cost of Rs. 12 lakhs during the first five years. A ceramic factory for the manufacture of crockery, insulators, sanitary wares, firebricks, fireclay, etc., will be established. The daily output is expected to be five tons of mixed crockery goods and insulators and 20 tons of firebrick and fireclay. The requisite materials are available in abundance in the State.

LINSEED OIL IN AUSTRALIA

A special variety of linseed oil, known as "Walsh" is to be produced in Australia. Contracts with flax-growers in several of the States for the supply of the necessary seed have been arranged by a leading oil marketing company. "Walsh" is resistant to rust, and there is an extensive world-wide market for the product. It is expected that in a few years Australia will be self-supporting in regard to linseed, imported from India at present.

DEVELOPMENT OF AMAZON TRACTS

Under the auspices of UNESCO a team of scientists, headed by Dr. E. J. M. Corner, are in Rio de Janeiro making preliminary studies for the establishment of an International Institute of the Hylean (Greek, for forestry) Amazon, probably at Para, Brazil.

Staffed by experts in all branches of science, the UNESCO Institute will study botanical, zoo-

logical, chemical, geological, meteorological, anthropological and medical facets of the area, as well as its potential habitability in terms of non-indigenous peoples.

Special attention will also be given by the scientists to medicinal products and other raw materials whose extraction may now be feasible with the use of modern equipment and methods. Explorers have pointed out that tribes in certain regions of the Amazon live totally free of cancer, raising the possibility that some element in their diet will provide a cure for the dread disease. The Amazon is also the largest forest region in the world, and its rubber resources are believed to be almost limitless.

MANGO-SEED KERNELS AS CATTLE FEED

Animal Nutrition workers at Izatnagar, India, report that mango-seed kernel forms a new source of valuable cattle feed, fairly rich in protein and carbohydrates. The feed is prepared by shelling the seed, slightly crushing the kernel and incorporating it up to three seers in the ration. The animals, after taking to the feed, gain weight and develop a healthy appearance.

SOVIET SCIENTISTS TO REPORT ON INDIA

"A Study of India" is the subject of a joint session of the History and Philosophy, Economics and Law, Literature and Language Departments of the Soviet Union Academy of Sciences which has opened in Moscow to discuss investigations of Soviet scientists in India's History, Literature and Economics.

The agenda of the session includes several scientific reports of economic consequences of the second World War for India, conditions of Indians in South Africa and the Asian Relations Conference in India which was held in March and April this year.

RESOLUTION AT CHEMISTS' CONGRESS

The Congress of Pure and Applied Chemistry at London, approved by acclamation the resolution sponsored by the Organic Chemist, Professor G. Morales Macedo of Peru.

The resolution said: "The eleventh International Congress of Pure and Applied Chemistry declare their wish that in future the science (chemistry) must be applied only to establish good relations and fraternity among different countries of the world."

B.H.U. COLLEGE OF TECHNOLOGY

Dr. Sadgopal has been appointed Professor of Oil and Soap Technology in the Department of Industrial Chemistry at the College of Technology, Benares Hindu University.

AWARD OF PH.D. DEGREES

The following research scholars have been awarded the degree of the Doctor of Philosophy:—

(1) Mr. O. Ramachandraiah (*Andhra*); (2) Mr. M. S. Muthanna (*Madras*); (3) Miss G. Sharada Bai (*Bombay*).

ERRATUM

Vol. 16, No. 6, June 1947, page 167: Article on "Technical Education in India": In the footnote *read* "Address by Mr. N. R. Sarkar" *for* "Address by Sir N. N. Sarkar".

AN APPEAL

EMERCENCY COMMITTEE OF ATOMIC SCIENTISTS

(INCORPORATED)

ROOM 28, 90 NASSAU STREET, PRINCETON, NEW JERSEY

April 30, 1947

TRUSTEES:

ALBERT EINSTEIN (*Chairman*).
HAROLD C. UREY (*Vice-Chairman*).
HANS A. BETHE. — LINUS PAULING.
T. R. HOGNESS. — LEO SZILARD.
PHILIP M. MORSE. — V. F. WEISSKOPF.

DEAR FRIEND,

Through the release of atomic energy, our generation has brought into the world the most revolutionary force since prehistoric man's discovery of fire. This basic power of the universe cannot be fitted into the outmoded concept of narrow nationalisms. For there is no secret and there is no defence; there is no possibility of control except when the aroused understanding and insistence of the peoples of the world.

We scientists recognize our inescapable responsibility to carry to our fellow-citizens an understanding of the simple facts of atomic energy and their implications for society. In this lie our only security and our only hope. We believe that an infomed citizenry will act for life and not for death.

We need $1,000,000 for this great educational task. Sustained by faith in man's ability to control his destiny through the exercise of reason, we have pledged all our strength and our knowledge to this work. I do not hesitate to call upon you to help.

Faithfully yours,
A. EINSTEIN.

[*We are confident our readers will extend their hearty and generous support to Prof. Albert Einstein's Appeal.*—EDITOR.]

734-47 Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent and Published by Dr. M. A. Govinda Raj, M.A., Ph.D., for The Current Science Association, Bangalore

INDUSTRY & CONTROL

LABORATORY EQUIPMENTS

Barkometer, English 10" 0-80% Rs. 17/8 ; Brinometer, English Rs. 9/8 each.

Beakers	100	250	500	1000	2000 c.c.
Indian	-/15/-	1/2	1/11	2/12	
English	2/7	2/11	4/6	5/14	11/14 each

Bottles Reagent flat stopper	4	8	16	32	64	oz.
Indian—Narrow mouth	10/14	14/4	18/8	30	82	per doz.
English ,,	18/14	25/8	35/4	60	192	,,

(*N.B.*—Wide mouth 25% extra ; Extra Wide mouth 75% extra)

Buretttes with stopcock—English 25 c.c. Rs. 11/8 ; 50 c.c. Rs. 13/8 ; 100 c.c. Rs. 16/8 ; Schellback 50 c.c. Rs. 17/8 ; 100 c.c. Rs. 19/8

Butryometers tube—English 8 to 9% as available Rs. 8/12

Desiccator, with zinc plate	4"	5"	6"	8"	10"
Indian	8/15	10/6	14/8	39	
English			30	55	84

Dessicator, Vacuum—English 8" Rs. 104

Distilling Apparatus, Copper—Capacity	1	2	4	10	20	Gallon
	Rs. 80	104	190	350	550	

Distilling Flask	250	500	1000	2000	3000	5000 c.c.
Indian	3/12	4/7	6/8	10/12		
English	7/15	9/8	14/8	19/8	26	32

Flask Capacity	250 c.c.	500 c.c.	1000 c.c.	2000 c.c.	3000 c.c.	5000 c.c.	10000
Indian	1/2	1/10	2/15	5	10/12	18/8	
English	2/10	4/8	5/14	9/8	14/8	23	38/8

Measuring Cylinder	100 c.c.	250 c.c.	500 c.c.	1000 c.c.	2000 c.c.	
Indian	2/6	3/4	5/8	9/8		Each
English	5	7/6	10/15	15/8	26/8	Each

Measuring Flasks, Stoppered	50 or 100 c.c.	250 c.c.	500 c.c.	1000 c.c.	2000 c.c.
Indian	2/3	2/14	4/6	5/13	
English	5/14	7/6	11/8	19/8	24/8

Measure Glass—English 4 oz. 8 oz. 16 oz. Rs. 3/10 ; 4/12 5/12 respectively 20 oz. 7/8 ; 32 oz. 12/8 each.

Pipettes Volumetric Sup.	1c.c.	2 c.c.	5 c.c.	10 c.c.	25 c.c.	50 c.c.
Indian	-/8/-	-/8/-	-/10/-	-/14/-	1/2	1/8
English	1	1/10	1/11	1/15	3/2	4/15
Graduated Sup. Indian	1	1/6	2	2/3	2/8	in 1/10
English	5/4	5/8	6	6/8	7/8	

Separating Funnels, English 100 c.c. 12/8 : 250 c.c. 14/12 ; 500 c.c. 21/8 ; 1000 c.c. 28/- ; 2000 c.c. 38/-.

Gum Boots—Indian Rs. 15/8 ; Superior Indian Rs. 19/8 ; English Rs. 39/-.

THE BANGALORE PRESS